PA. ENT COOPERATION TREAT

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From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 20 February 2002 (20.02.02)	
International application No. PCT/KR01/00166	**Applicant's or agent's file reference**
International filing date (day/month/year) 06 February 2001 (06.02.01)	**Priority date** (day/month/year) 30 May 2000 (30.05.00)
Applicant PARK, Su, Won et al	

1. The designated Office is hereby notified of its election made:

   [X] in the demand filed with the International Preliminary Examining Authority on:

   27 November 2001 (27.11.01)

   [ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was [ ] was not

   made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland** Facsimile No.: (41-22) 740.14.35	Authorized officer Pascal Piriou Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

LEE, Jong, Il
#904 BYC Building
648-1, Yeoksam-dong
Kangnam-ku
Seoul 135-080
RÉPUBLIQUE DE CORÉE

Date of mailing (day/month/year) 25 March 2002 (25.03.02)	
Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
International application No. PCT/KR01/00166	**International filing date** (day/month/year) 06 February 2001 (06.02.01)

1. The following indications appeared on record concerning:
[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address	State of Nationality	State of Residence
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:
[X] the person [ ] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address	State of Nationality	State of Residence
ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE #161, Gajon-dong Yusong-gu Daejon 305-350 Republic of Korea	KR	KR
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:
Electronics And Telecommunications Research Institute is added applicant for all designated states except US.

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[X] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland** Facsimile No.: (41-22) 740.14.35	Authorized officer Kiwa MPAY Telephone No.: (41-22) 338.83.38

The demand must be filed directly with the competent International Preliminary examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by th applicant on th line below:

IPEA/ KR

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States(except where otherwise indicates).

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND

Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION		Applicant's or agent's file reference S000-00-T004
International application No. PCT/KR01/00166	International filing date*(day/month/year)* 06 FEBRUARY 2001(06.02.2001)	(earliest)Priority date*(day/month/year)* 30 MAY 2000(30.05.2000)

Title of invention

Multi-Dimensional Orthogonal Hopping Multiplexing Communications Method and Apparatus

Box No. II APPLICANT(S)

Name and address:*(Family name followed by given name: for a legal entity, full official designation. The address must include postal code and name of country.)*

KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY

#373-1, Kusong-dong, Yusong-gu, Taejon, 305-701

Republick of Korea

Telephone No.: 82-42-869-2183

Facsimile No.: 82-42-869-2190

Teleprinter No.:

State*(that is, country)*of nationality:	State*(that is, country)*of residence:
KR	KR

Name and address:*(Family name followed by given name: for a legal entity, full official designation. The address must include postal code and name of country.)*

PARK, Su Won

Departmant of Electrical Engineering, KAIST.

Kusong-dong, Yusong-gu, Taejon. 305-701, Republick of Korea

State*(that is, country)*of nationality:	State*(that is, country)*of residence:
KR	KR

Name and address:*(Family name followed by given name: for a legal entity, full official designation. The address must include postal code and name of country.)*

SUNG, Dan Keun

103-1503, Hanwool APT, Shinsung-dong, Yusong-gu, Taejon,

Republick of Korea

State*(that is, country)*of nationality:	State*(that is, country)*of residence:
KR	KR

☐ Further applicants are indicated on a continuation sheet.

Sheet No. 2

International application No. PCT/KR01/00166

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The following person is [x] agent [ ] common representative

and [ ] has been appointed earlier and represents the applicant(s) also for international preliminary examination.

[ ] is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.

[ ] is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

LEE, Jong Il

#904 BYC Bldg., 648-1, Yeoksam-dong, Kangnam-gu,
Seoul, 135-080
Republick of Korea

Telephone No. 82-2-554-3026

Facsimile No. 82-2-554-3028

Teleprinter No.

Agent's registration No. with the Office 9-1998-000471-4

[ ] Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION

Statement concerning amendments:*

1. The applicant wishes the international preliminary examination to start on the basis of:

[x] the international application as originally filed

the description [ ] as originally filed
[ ] as amended under Article 34

the claims [ ] as originally filed
[ ] as amended under Article 19 (together with any accompanying statement)
[ ] as amended under Article 34

the drawings [ ] as originally filed
[ ] as amended under Article 34

2. [ ] The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.

3. [ ] The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English

[x] which is the language in which the international application was filed.
[ ] which is the language of a translation furnished for the purposes of international search.
[ ] which is the language of publication of the international application.
[ ] which is the language of the translation (to be) furnished for the purposes of international preliminary examination.

Box No. V ELECTION OF STATES

The applicant hereby elects all eligible States *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes not to elect:

Sheet No. 3

International application No.
PCT/KR01/00166

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

			For International Preliminary Examining Authority use only: received	not received
1. translation of international application	:	sheets	☐	☐
2. amendments under Article 34	:	sheets	☐	☐
3. copy (or, where required, translation) of amendments under Article 19	:	sheets	☐	☐
4. copy (or, where required, translation) of statement under Article 19	:	sheets	☐	☐
5. letter	:	sheets	☐	☐
6. other (specify)	:	sheets	☐	☐

The demand is also accompanied by the item(s) marked below:

1. [X] fee calculation sheet
2. ☐ original separate power of attorney
3. ☐ original general power of attorney
4. ☐ copy of general power of attorney; reference number, if any:
5. ☐ statement explaining lack of signature
6. ☐ sequence listing in computer readable form
7. ☐ other *(specify)*:

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

LEE, Jong Il (Seal)

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply. ☐ The applicant has been informed accordingly.

4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.

5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

Form PCT/IPEA/401 (last sheet) (March 2001)

See Notes to the demand form.

CHAPTER II

PCT

FEE CALCULATION SHEET

Annex to the Demand

International application No. PCT/KR01/00166

Applicant's or agent's file reference 5000-00-T004

For International Preliminary Examining Authority use only

Date stamp of the IPEA

Applicant

KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY et al.

CALCULATION OF PRESCRIBED FEES

1. Preliminary examination fee .... KRW 150,000 P

2. Handling fee *(Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.)* .... KRW 179,000 H

3. Total of prescribed fees
Add the amounts entered at P and H and enter total in the TOTAL box .... KRW 329,000 TOTAL

MODE OF PAYMENT

- [ ] authorization to charge deposit account with the IPEA (see below)
- [ ] cheque
- [ ] postal money order
- [ ] bank draft
- [X] cash
- [ ] revenue stamps
- [ ] coupons
- [ ] other *(specify)*:

AUTHORIZATION TO CHARGE (OR CREDIT) DEPOSIT ACCOUNT

(This mode of payment may not be available at all IPEAs)

- [ ] Authorization to charge the total fees indicated above.
- [ ] *(This check-box may be marked only if the conditions for deposit accounts of the IPEA so permit)* Authorization to charge any deficiency or credit any overpayment in the total fees indicated above.

IPEA/ ____________________

Deposit Account No.: ____________________

Date: ____________________

Name: ____________________

Signature: ____________________

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF RECEIPT OF RECORD COPY

(PCT Rule 24.2(a))

To:

LEE, Jong, Il
#904 BYC Building
648-1, Yeoksam-dong
Kangnam-ku
Seoul 135-080
RÉPUBLIQUE DE CORÉE

RECEIVED 2001. 4. 02 大一特許 DAEIL INT'L PATENT & LAW OFFICE

Date of mailing (day/month/year) 19 March 2001 (19.03.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference	International application No. PCT/KR01/00166

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY (for all designated States except US)
PARK, Su, Won et al (for US)

International filing date	:	06 February 2001 (06.02.01)
Priority date(s) claimed	:	30 May 2000 (30.05.00)
Date of receipt of the record copy by the International Bureau	:	07 March 2001 (07.03.01)
List of designated Offices	:	

AP :GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZW
EA :AM,AZ,BY,KG,KZ,MD,RU,TJ,TM
EP :AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE,TR
OA :BF,BJ,CF,CG,CI,CM,GA,GN,GW,ML,MR,NE,SN,TD,TG
National :AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CR,CU,CZ,DE,DK,DM,DZ,EE, ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD, MG,MK,MN,MW,MX,MZ,NO,NZ,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,US,UZ, VN,YU,ZA,ZW

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 740.14.35	Authorized officer: R. Chrem Telephone No. (41-22) 338.83.38

Continuation of Form PCT/IB/301

NOTIFICATION OF RECEIPT OF RECORD COPY

Date of mailing (day/month/year) 19 March 2001 (19.03.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference	International application No. PCT/KR01/00166

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- [X] time limits for entry into the national phase
- [X] confirmation of precautionary designations
- [ ] requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated in the Notification of Receipt of Record Copy (Form PCT/IB/301) by paying national fees and furnishing translations, as prescribed by the applicable national laws.

The time limit for performing these procedural acts is **20 MONTHS** from the priority date or, for those designated States which the applicant elects in a demand for international preliminary examination or in a later election, **30 MONTHS** from the priority date, provided that the election is made before the expiration of 19 months from the priority date. Some designated (or elected) Offices have fixed time limits which expire even later than 20 or 30 months from the priority date. In other Offices an extension of time or grace period, in some cases upon payment of an additional fee, is available.

In addition to these procedural acts, the applicant may also have to comply with other special requirements applicable in certain Offices. **It is the applicant's responsibility** to ensure that the necessary steps to enter the national phase are taken in a timely fashion. Most designated Offices do not issue reminders to applicants in connection with the entry into the national phase.

For detailed information about the procedural acts to be performed to enter the national phase before each designated Office, the applicable time limits and possible extensions of time or grace periods, and any other requirements, see the relevant Chapters of Volume II of the PCT Applicant's Guide. Information about the requirements for filing a demand for international preliminary examination is set out in Chapter IX of Volume I of the PCT Applicant's Guide.

GR and ES became bound by PCT Chapter II on 7 September 1996 and 6 September 1997, respectively, and may, therefore, be elected in a demand or a later election filed on or after 7 September 1996 and 6 September 1997, respectively, regardless of the filing date of the international application. (See second paragraph above.)

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date. If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with an indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity to furnish the priority document within a time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

LEE, Jong Il

#904, BYC Bldg., 648-1, Yeoksam-dong, Kangnam-gu, Seoul
135-080, Republic of KOREA

PCT

NOTIFICATION OF RECEIPT OF DEMAND BY COMPETENT INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

(PCT Rule 59.3(e) and 61.1(b), first sentence and Administrative Instructions, Section 601(a))

Date of mailing (*day/month/year*) 29 JANUARY 2002 (29.01.2002)

Applicant's or agent's file reference S000-00-T004	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/KR01/00166	06 FEBRUARY 2001 (06.02.2001)	30 MAY 2000 (30.05.2000)

Applicant

KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY et al

1. The applicant is hereby **notified** that this International Preliminary Examining Authority considers the following date as the date of receipt of the demand for international preliminary examination of the international application:

27 NOVEMBER 2001 (27.11.2001)

2. This date of receipt is :

- [X] the actual date of receipt of the demand by this Authority (Rule 61.1(b)).
- [ ] the actual date of receipt of the demand on behalf of this Authority (Rule 59.3(e)).
- [ ] the date on which this Authority has, in response to the invitation to correct defects in the demand (Form PCT/IPEA/404), received the required corrections.

3. [ ] **ATTENTION**: That date of receipt is **AFTER** the expiration of 19 months from the priority date. Consequently, the election(s) made in the demand does (do) not have the effect of postponing the entry into the national phase until 30 months from the priority date (or later in some Offices) (Article 39(1)). Therefore, the acts for entry into the national phase must be performed within 20 months from the priority date (or later in some Offices) (Article 22). For details, see the *PCT Applicant's Guide*, Volume II.

   [ ] *(If applicable)* This notification confirms the information given by telephone, facsimile transmission or in person on:

4. Only where paragraph 3 applies, a copy of this notification has been sent to the International Bureau.

Name and mailing address of the IPEA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 920 Dunsan-dong, Seo-gu, Daejeon Metropolitan City 302-701, Republic of Korea	COMMISSIONER
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5210

Form PCT/IPEA/402 (July 1998)

P.B.5818 · Patentlaan 2
2280 HV Rijswijk (ZH)
☏ +31 70 340 2040
TX 31651 epo nl
FAX +31 70 340 3016

Europäisches Patentamt
Eingangsstelle

European Patent Office
Receiving Section

Office européen des brevets
Section de Dépôt

LEE, Jong, Il
904 BYC Building
648-1, Yeoksam-dong
Kangnam-ku
Seoul 135-080

REPUBLIQUE DE COREE

Datum/Date
13/12/01

Zeichen/Ref./Réf.	Anmeldung Nr./Application No./Demande n°/Patent Nr./Patent No./Brevet n°.
	01906365.0- -PCT/KR0100166

Anmelder/Applicant/Demandeur/Patentinhaber/Proprietor/Titulaire
KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY

ENTRY INTO THE EUROPEAN PHASE BEFORE THE EUROPEAN PATENT OFFICE

NOTE: These notes describes the procedural steps required for entry into the European phase before the European Patent Office (EPO). You are advised to read them carefully; failure to take the necessary action in time can lead to your application being deemed withdrawn.

1. European patent application no. 01906365.0 has been allotted to the above-mentioned international patent application.

2. Applicants WITHOUT a residence or their principal place of of business within the territory of an EPC Contracting State may themselves initiate European processing of their international application, provided they do so before expiry of the 21st or 31st month from the the priority date (see also point 7 below).

   During the European phase before the EPO as designated or elected Office, however, such applicants must be represented by a proprofessional representative (Articles 133(2) and 134(7) EPC).

   Procedural acts performed after expiry of the 21st or 31st month by a professional representative who acted during the international phase but is not authorised to act before the EPO have no legal effect and therefore lead to loss of rights.

   Please note that a professional representative authorised to act before the EPO and who acted for the applicant during the international phase does not automatically become the representative for the European phase. Applicants therefore strongly advised to appoint in good time any representative they wish to initiate the European phase for them; otherwise, the EPO has to send all communications direct to the applicant.

3. Applicants WITH a residence or their principal place of business within the territory of an EPC Contractin State are not obliged to appoint a professional representative authorised to act before the EPO for the European phase before the EPO as a designated or elected Office.
   However, in view of the complexity of the procedure it is recommended that they do so.

4. Applicants and professional representatives are strongly advised to initiate the European phase using EPO Form 1200 (available free of charge from the EPO). This however is not compulsory.

5. TO ENTER THE EUROPEAN PHASE BEFORE THE EPO, the following acts must be performed. (NB: Failure validly to do so will entail loss of rights or other adverse legal consequences).

   5.1 If the EPO acting as DESIGNATED OFFICE under Article 22(1) PCT, applicants must, within 21 months from the date of filing or (where applicable) the earliest priority date:

   a) Supply a translation of the international application into an EPO official language, if the International Bureau did not publish the application in such a language (Article 22(1) PCT and Rule 107(1)a) EPC).
      If the translation is not filed in due time, the international application is deemed to be withdrawn before the EPO (Article 24(1)(iii) PCT).

   b) Pay the national basic fee and, where a supplementary European search report has to be drawn up, the search fee (Rule 107(1)c) and e) EPC).

   c) Within six months from publication of the international search report, pay a designation fee for each designated Contracting State (Rule 107(1)d) EPC), and file a written request for examination and pay the examination fee (Rule 107(1)f) EPC).

5.2 If the EPO is acting as ELECTED OFFICE under Article 39(1)a) PCT, applicants must, within 31 months from the date of filing or (where applicable) the earliest priority date:

a) File a translation as per 5.1 a) above.

b) Pay the fees as per 5.1 b) above.

c) If the time limit under Article 79(2) EPC expires before the 31-month time limit, pay the designation fee for each designated Contracting State (Rule 107(1)d) EPC).

d) If the time limit under Article 94(2) EPC expires before the 31-month time limit, file the written request for examination A N D pay the examination fee (Rule 107(1)f) EPC).

e) Pay the renewal fee for the third year, if it falls due before the expiry of the 21-month time limit (Rule 107(1)g) EPC)

5.3 If the application documents on which the European grant procedure is to be based comprise more then ten claims, a claims fee is payable within the time limit under Rule 107(1) EPC for the eleventh and each subsequent claim (Rule 110(1) EPC). The fee can however still be paid within a period of grace of one month from notification of an EPO communication (Rule 110(2) EPC).

6. If the necessary fees are not paid in time, they may still be validly paid within a period of grace of one month from notification of an EPO communication, subject to payment at the same time of a surcharge for each late-paid fee (Rule 85a(1), 85b EPC).
For the renewal fee, the period of grace is six months from the fee's due date (Article 86(2) EPC).

7. If the applicant had a representative during the application's international phase, the present notes will be sent to the representative, asking him to inform the applicant accordingly.

All subsequent communications will be sent to the applicant, or - if the EPO is informed of his appointment in time - to the applicants's European representative.

8. For more details about time limits and procedural acts before the EPO as designated and elected Office, see the EPO brochure

   How to get a European patent
   Guide for applicants - Part 2
   PCT procedure before the EPO - "EURO-PCT"

   This brochure, the list of professional representatives before the EPO, Form 1200 and the latest fees are all on the internet under

   http://www.european-patent-office.org.

RECEIVING SECTION

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

To:
LEE, Jong, Il
#904 BYC Building
648-1, Yeoksam-dong
Kangnam-ku
Seoul 135-080
RÉPUBLIQUE DE CORÉE

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

Date of mailing (day/month/year) 06 December 2001 (06.12.01)		
Applicant's or agent's file reference	**IMPORTANT NOTICE**	
International application No. PCT/KR01/00166	International filing date (day/month/year) 06 February 2001 (06.02.01)	Priority date (day/month/year) 30 May 2000 (30.05.00)
Applicant KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY et al		

1. Notice is hereby given that the International Bureau has **communicated**, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this notice:
   KP,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AG,AL,AM,AP,AT,AU,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CR,CU,CZ,DE,DK,DM,DZ,EA,EE,EP,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,MZ,NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,

   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this notice is a copy of the international application as published by the International Bureau on 06 December 2001 (06.12.01) under No. WO 01/93479

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a **demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination (at present, all PCT Contracting States are bound by Chapter II).

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and the PCT Applicant's Guide, Volume II.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.91.11

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

LEE, Jong, Il
#904 BYC Building
648-1, Yeoksam-dong
Kangnam-ku
Seoul 135-080
RÉPUBLIQUE DE CORÉE

Date of mailing (day/month/year) 19 March 2001 (19.03.01)	
Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
International application No. PCT/KR01/00166	International filing date (day/month/year) 06 February 2001 (06.02.01)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 30 May 2000 (30.05.00)
Applicant KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
30 May 2000 (30.05.00)	2000/29400	KR	07 Marc 2001 (07.03.01)

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland** Facsimile No. (41-22) 740.14.35	Authorized officer R. Chrem Telephone No. (41-22) 338.83.38

Form PCT/IB/304 (July 1998)

003904583

PATENT COOPERATION TREATY

From the RECEIVING OFFICE

To:

LEE, Jong Il

#904, BYC Bldg., 648-1, Yeoksam-dong, Kangnam-gu,
Seoul 135-080, Republic of KOREA

RECEIVED
2001 3 02

PCT

NOTIFICATION OF THE INTERNATIONAL APPLICATION NUMBER AND OF THE INTERNATIONAL FILING DATE

(PCT Rule 20.5(C))

Date of mailing *(day/month/year)*	22 FEBURUARY 2001 (22.02.2001)
Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/KR01/00166	06 FEBRUARY 2001 (06.02.2001)	30 MAY 2000 (30.05.2000)

Applicant

KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY et al

Title of the invention

MULTI-DIMENSIONAL ORTHOGONAL HOPPING MULTIPLEXING COMMUNICATIONS METHOD AND APPARATUS

1. The applicant is hereby notified that the international application has been accorded the international application number and the international filing date indicated above.

2. The applicant is further notified that the record copy of the international application:

   ☐ was transmitted to the International Bureau on ______________________

   ☐ has not yet been transmitted to the International Bureau for the reason indicated below and a copy of this notification has been sent to the International Bureau*:

      ☐ because the necessary national security clearance has not yet been obtained.

      ☐ because *(reason to be specified)*:

* The International Bureau monitors the transmittal of the record copy by the receiving Office and will notify the applicant (with Form PCT/IB/301) of its receipt. Should the record copy not have been received by the expiration of 14 months from the priority date, the International Bureau will notify the applicant (Rule 22.1(c)).

Name and mailing address of the receiving Office	Authorized officer
Korean Industrial Property Office Government Complex-Taejon, Dunsan-dong, So-ku, Taejon Metropolitan City 302-701, Republic of Korea	COMMISSIONER
Facsimile No. 82-42-472-3466	Telephone No. 82-42-481-5762

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum)

Box No. I TITLE OF INVENTION MULTI-DIMENSIONAL ORTHOGONAL HOPPING MULTIPLEXING COMMUNICATIONS METHOD AND APPARATUS

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY
#373-1 Kusong-dong, Yusong-gu, Taejon 305-701,
Republick of Korea

☐ This person is also inventor.

Telephone No.: (82-42) 869-4731

Facsimile No.: (82-42) 869-4275

Teleprinter No.:

State (that is, country) of nationality: KR

State (that is, country) of residence: KR

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

PARK, Su Won
Department of Electrical Engineering, KAIST,
Kusong-Dong, Yusong-Ku,
Taejon, 305-701, Republic of Korea

This person is:
☐ applicant only
☒ applicant and inventor
☐ inventor only (if this check-box is marked, do not fill in below)

State (that is, country) of nationality: KR

State (that is, country) of residence: KR

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common resentative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

LEE, Jong Il
#904 BYC Building
648-1, Yeoksam-dong, Kangnam-ku,
Seoul, 135-080
Republic of Korea

Telephone No.: (82-2) 554-3026

Facsimile No.: (82-2) 554-3028

Teleprinter No.:

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Sheet No. 2

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

SUNG, Dan Keun
103-1503, Hanwool APT
Shin Sung-Dong, Yusong-Ku,
Taejon, 305-345, Republic of Korea

This person is:
- [ ] applicant only
- [X] applicant and inventor
- [ ] inventor only *(if this check-box is amred, do not fill in below)*

State *(that is, country)* of nationality: KR
State *(that is, country)* of residence: KR

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [X] the United States of America only [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(if this check-box is amred, do not fill in below)*

State *(that is, country)* of nationality: KR
State *(that is, country)* of residence: KR

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [ ] the United States of America only [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(if this check-box is amred, do not fill in below)*

State *(that is, country)* of nationality:
State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [ ] the United States of America only [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(if this check-box is amred, do not fill in below)*

State *(that is, country)* of nationality:
State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] all designated States except the United States of America [ ] the United States of America only [ ] the States indicated in the Supplemental Box

[ ] Further applicants and/or (further) inventors are indicated on another continuation sheet.

Sheet No. 3

Box No. V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes: at least one must be marked):*

Regional Patent

- ☐ **AP** ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, MZ Mozambique, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ **EA** Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☐ **EP** European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA** OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Cote d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* ....

National Patent *(if other kind of protection or treatment desired, specify on dotted line):*

- ☒ **AE** United Arab Emirates
- ☐ **AG** Antigua and Barbuda
- ☒ **AL** Albania ....
- ☒ **AM** Armenia ....
- ☒ **AT** Austria ....
- ☒ **AU** Australia ....
- ☒ **AZ** Azerbaijan
- ☒ **BA** Bosnia and Herzegovina ....
- ☒ **BB** Barbados
- ☒ **BG** Bulgaria ....
- ☒ **BR** Brazil ....
- ☒ **BY** Belaus ....
- ☒ **BZ** Belize
- ☒ **CA** Canada
- ☒ **CH and LI** Switzerland and Liechtenstein
- ☒ **CN** China ....
- ☒ **CR** Costa Rica ....
- ☒ **CU** Cuba ....
- ☒ **CZ** Czech Republic ....
- ☒ **DE** Germany ....
- ☒ **DK** Denmark ....
- ☒ **EE** Estonia ....
- ☒ **ES** Spain
- ☒ **DM** Dominica
- ☐ **DZ** Algeria ....
- ☐ **FI** Finland ....
- ☒ **GB** United Kingdom
- ☒ **GD** Grenada
- ☒ **GE** Georgia ....
- ☒ **GH** Ghana ....
- ☒ **GM** Gambia
- ☒ **HR** Croatia ....
- ☒ **HU** Hungary ....
- ☒ **ID** Indonesia
- ☒ **IL** Israel ....
- ☒ **IN** India ....
- ☒ **IS** Iceland
- ☒ **JP** Japan ....
- ☒ **KE** Kenya ....
- ☒ **KG** Kyrgyzstan ....
- ☒ **KP** Democratic People's Republic of Korea ....
- ☐ **KR** Republic of Korea ....
- ☒ **KZ** Kazakhstan
- ☒ **LC** Kazakhstan
- ☐ **LK** Sri Lanka
- ☒ **LR** Liberia ....
- ☒ **LS** Lesotho
- ☒ **LT** Lithuania ....
- ☒ **LU** Luxembourg
- ☒ **LV** Latvia
- ☒ **MA** Morocco ....
- ☒ **MD** Republic of Moldova ....
- ☒ **MG** Madagascar ....
- ☒ **MK** the former Yugoslav Republic of Macedonia ....
- ☒ **MN** Mongolia ....
- ☒ **MW** Malawi ....
- ☒ **MX** Mexico ....
- ☒ **MZ** Mozambique
- ☒ **NO** Norway
- ☒ **NZ** New Zealand ....
- ☒ **PL** Poland
- ☒ **PT** Portugal ....
- ☒ **RO** Romania
- ☒ **RU** Russian Federation ....
- ☒ **SD** Sudan
- ☒ **SE** Sweden
- ☒ **SG** Singapore
- ☒ **SI** Slovenia ....
- ☒ **SK** Slovakia ....
- ☒ **SL** Sierra Leone ....
- ☒ **TJ** Tajikistan ....
- ☒ **TM** Turkmenistan ....
- ☒ **TR** Turkey ....
- ☒ **TT** Trinidad and Tobago ....
- ☒ **TZ** United Republic of Tanzania
- ☒ **UA** Ukraine ....
- ☒ **UG** Uganda ....
- ☒ **US** United States of America
- ☒ **UZ** Uzbekistan ....
- ☒ **VN** Viet Nam ....
- ☒ **YU** Yugoslavia ....
- ☒ **ZA** South Africa ....
- ☒ **ZW** Zimbabwe ....

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- ☐ ....

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(S) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplement Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: regional Office
item(1) 30 May. 2000 (30/05/2000)	2000-29400	KR		
item(2)				
item(3)				

☐ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s):

* *Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplementary Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed(Rule 4.10(b)(ii) See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority(ISA) *(if two or more International Searching Authorities are competent to carry the international search, indicate the Authority chosen, the two-letter code may be used)*:

ISA/ AT

Request to use the results of earlier search: reference to that search*(if an earlier search has been carried out or requested from the International Searching Authority)*:

Date*(day/month/year)* Number Country*(or regional Office)*

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following number of sheets:

request	: 4
description(excluding sequence listing part)	: 66
claims	: 19
abstract	: 1
drawings	: 44
sequence listing part of description	:
Total number of sheets	: 134

This international application is accompanied by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☒ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☒ priority document(s) identified in Box No. VI as item(s)
6. ☐ translation of international application into(language)
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer reader form
9. ☐ other*(specify)* :

Figure of the drawings which should accompany the abstract: 10d

Language of filing of the international application: English

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs(if such capacity is not obvious from reading the request).

LEE, Jong Il (SEAL)

1. Date of actual receipt of the purported international application :	2. Drawings:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application :	☐ received:
4. Date of timely receipt of the required corrections under PCT Article 11(2) :	☐ not received:
5. International Searching Authority (if two or more are competent) : ISA/	6. ☐ Transmittal of search copy delayed until search fee is paid

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

This sheet is not part of and does not count as a sheet of the international application

PCT
FEE CALCULATION SHEET
Annex to the Request

For receiving Office use only

International application No.

Date stamp of the receiving Office

Applicant's or agent's file reference: S000-00-T004

Applicant: Korea Advanced Institute of Science and Technology

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE .... KRW 45.000 T

2. SEARCH FEE .... KRW159.500 S

International search to be carried out by ________

(if two or more International Searching Authorities are competent in relation to the international application, indicate the name of the Authority which is chosen to carry out the international search)

3. INTERNATIONAL FEE

Basic Fee

The international application contains 134 sheets.

first 30 sheets .... KRW 425.800 b1

104 (remaining sheets) x KRW 9.800 (additional amount) = KRW1.019.200 b2

Add amounts entered at b1 and b2 and enter total at B .... KRW 1.445.000 B

Designation Fees

The international application contains 86 designations.

6 (number of designation fees payable *(maximum 6)*) x KRW 91.700 (amount of designation fee) = KRW 550.200 D

Add amounts entered at B and D and enter total I .... KRW 1.995.200 I

(Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the sum of the amounts entered at B and D)

4. FEE FOR PRIORITY DOCUMENT *(if applicable)* ________ P

5. TOTAL FEES PAYABLE

Add amounts entered at T, S, I and P, and enter total in the TOTAL box: KRW 2.199.700 TOTAL

☐ The designation fees are not paid at this time.

MODE OF PAYMENT

☐ Authorization to charge deposit account (see below)	☐ bank draft	☐ coupons
☐ cheque	☒ cash	☐ other *(specify)*
☐ postal money order	☐ revenue stamps	

DEPOSIT ACCOUNT AUTHORIZATION *(this mode of payment may not be available at all receiving Offices)*

The RO/ ____ ☐ is hereby authorized to charge the total fees indicated above to my deposit account.

☐ *(this check-box may be marked only if the conditions for deposit accounts of the receiving Office so permit)* is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

☐ is hereby authorized to charge the fee for preparation and transmittal of the priority document to the International Bureau of WIPO to my deposit account.

Deposit Account Number ________ Date *(day/month/year)* ________ signature ________

INTERNATIONAL . .ARCH REPORT

Internat. .pplication No.
PCT/KR 01/00166

CLASSIFICATION OF SUBJECT MATTER

IPC^7: H04J 11/00, H04B 1/713

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC^7: H04B 1/69, 1/713, H04J 11/00,13/00, H04L 5/06, 27/26, 27/30, H04Q 11/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0902549 A2 (SAMSUNG ELECTRONICS CO. LTD.) 17 March 1999 (17.03.99) *figs. 4,6; claims 1-9.*	1-5,17,19,37, 39,46,47,58,59
A	US 5548582 A (BRAJAL, A. et al.) 20 August 1996 (20.08.96) *claims 1-6.*	1-5,32,33,39-42,52,57,59
A	EP 0874530 A1 (AT&T CORP.) 28 October 1998 (28.10.98) *claims 1,7,14,18.*	1,2,6,10,14,52

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
„A" document defining the general state of the art which is not considered to be of particular relevance
„E" earlier application or patent but published on or after the international filing date
„L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
„O" document referring to an oral disclosure, use, exhibition or other means
„P" document published prior to the international filing date but later than the priority date claimed

„T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
„X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
„Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
„&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2001 (13.06.2001)	3 July 2001 (03.07.2001)

Name and mailing adress of the ISA/AT	Authorized officer
Austrian Patent Office Kohlmarkt 8-10; A-1014 Vienna	FUSSY
Facsimile No. 1/53424/535	Telephone No. 1/53424/328

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP A1 874530	28-10-1998	CA AA 2233126	22-10-1998
		JP A2 10303941	13-11-1998
		US BA 6229821	08-05-2001
EP A2 902549	17-03-1999	CN A 1278129	27-12-2000
EP A3 902549	02-11-2000	JP A2 11163827	18-06-1999
		JP B2 3093182	03-10-2000
US A 5548582	20-08-1996	EP A1 660559	28-06-1995
		JP A2 7288491	31-10-1995
		SG A1 48266	17-04-1998

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
6 December 2001 (06.12.2001)

PCT

(10) International Publication Number
WO 01/93479 A1

(51) International Patent Classification[7]: H04J 11/00, H04B 1/713

(21) International Application Number: PCT/KR01/00166

(22) International Filing Date: 6 February 2001 (06.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2000/29400 30 May 2000 (30.05.2000) KR

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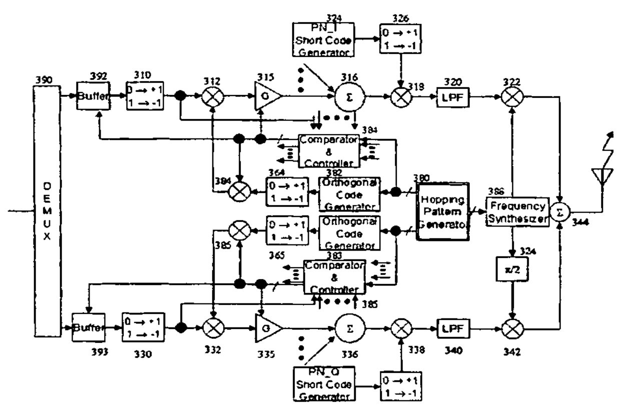
(54) Title: MULTI-DIMENSIONAL ORTHOGONAL RESOURCE HOPPING MULTIPLEXING COMMUNICATIONS METHOD AND APPARATUS



(57) Abstract: The present invention is related to a statistical multiplexing method and apparatus using a multi-dimensional orthogonal resource hopping multiplexing method in a wired/wireless communication systems where a plurality of communication channels, which are synchronized through a single medium, coexist. The present invention, in order to implement a generalized statistical multiplexing communication system using a multi-dimensional orthogonal resource hopping multiplexing method, comprises a multi-dimensional hopping pattern generator which is located in the primary communication station, a data symbol modulator that modulates data symbols based on the corresponding orthogonal resource hopping pattern generated by said multi-dimensional hopping pattern generator, a collision detector and controller that detects whether a collision occurs or not between the multi-dimensional hopping patterns and compares the consistency of the data symbols toward the secondary communication stations between said collision interval, a transmission power controller that controls the transmission power of the remaining parts excluding the parts where the multi-dimensional hopping patterns collide and the transmission is stopped due to transmitting data symbol inconsistency and compensates for the loss in the average reception energy due to a transmission stoppage.

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Multi-Dimensional Orthogonal Resource Hopping Multiplexing Communications Method and Apparatus

TECHNICAL FIELD

The present invention is related to a statistical multiplexing method and apparatus for the channels using a multi-dimensional orthogonal resource hopping multiplexing method when the data transmission rate for each channel has an average transmission rate which is lower than the basic transmission rate (R) in digital communication systems where a plurality of communication channels synchronized through a single medium with a low degree of activity co-exist.

More specifically, the present invention is related to a statistical multiplexing method and apparatus wherein the primary communication station identifies each channel of the secondary communication station by the multi-dimensional orthogonal resource hopping pattern in which the system comprises a primary communication station that synchronizes a plurality of channels to secondary communication stations; the multi-dimensional orthogonal resource hopping pattern corresponding to a secondary communication station comprises a designated hopping pattern assigned at the time of a call establishment or a pseudo-random hopping pattern unique to the secondary communication station; when the

multi-dimensional orthogonal resource coordinates within the hopping patterns of more than two channels at any moment are the same (herein referred to as "collision of multi-dimensional orthogonal resource hopping patterns"), all the transmitting channels from the primary communication station involved with the collision are compared and if at least one channel transmits data symbol different from other channels, then the corresponding symbol interval is switched off (punctured or not transmitted) and in order to supplement the symbol energy of the lost data belonging to all the channels involved, the transmission power of all the channels whose data symbol transmission have been switched off can be increased at the corresponding interval in such an amount that is stipulated in the Communication Protocol.

As an example of multiplexing communication system, a mobile communication system IS-95 which is a prior art which has been laid open.

The digital and analog frequency division multiplexing (FDM) communication systems according to a prior art, communicate through allocation of an empty frequency allocation to a secondary communication station by the primary communication station at the time of a call establishment irrespective of the degree of channel activity and other secondary communication stations are allowed to utilize the available frequency channels released at the time of call termination.

The Time Division Multiplexing (TDM) communication

systems according to a prior art, communicate through allocation of an time slot amongst a multitude of time slots which has not been allocated to a secondary communication station by the primary communication station at the time of a call establishment irrespective of the degree of channel activity and other secondary communication stations are allowed to utilize the available time slots released at the time of call termination.

The Frequency Hopping Multiplexing (FHM) communication system according to a prior art, communicates between the primary and secondary communication stations through a prearranged frequency hopping pattern.

The Orthogonal Code Division Multiplexing (OCDM) communication system according to a prior art, communicates through allocation of an orthogonal code symbol within the orthogonal code which has not been allocated to a secondary communication station by the primary communication station at the time of a call establishment irrespective of the degree of channel activity, and other secondary communication stations are allowed to utilize the available orthogonal code symbol released at the time of call termination.

BACKGROUND ART

The embodiments of prior arts pertaining to multiplexing method which have been laid open are described as below.

FIG. 1 illustrates the system according to the embodiments of the prior arts and present invention, all communication channels from the primary communication station 101 to the secondary communication stations 111, 112, 113 are synchronized and also orthogonal to each other.

FIG. 2a is a block diagram of the transmitter of the primary communication station which corresponds to the common constituent parts in the embodiments of the prior arts and present invention, FIG. 2b is a block diagram of the transmitter of the primary communication station on traffic channel in the embodiments of the prior arts. The pilot channel 200 should exist per each Sub-Carrier (SC) because it is used as a channel estimation signal for the purpose of initial synchronization acquisition, tracking and coherent demodulation by the secondary communication station, as shown in FIG. 1, and shared by all the secondary communication stations in the area covered by the primary communication station. As illustrated in FIG. 2a, it also provides a phase reference for coherent demodulation by sending the known symbols. The synchronization channel 210 along with the pilot channel 200 is a one-way broadcasting channel that is broadcast to all the secondary communication stations in the area covered by the primary communication station, and the commonly required information by all the secondary communication stations are transmitted from the primary communication station (i.e., time information and the identifier of the primary communication station).

The data from the synchronization channel pass through a convolution encoder 214, a symbol repeater for adjusting a symbol rate 216, a block interleaver 218 for converting bursty errors to random errors and a symbol repeater 219 for matching a transmitting data symbol rate and are then transmitted to a spreading and modulation block, shown in FIGs. 3a-3f. A paging channel 220 shown in FIG. 2a is a common channel used in case of an incoming message to the secondary communication station or for responding to a request of the secondary communication station. Multiple paging channels 220 can exist.

The data transmitted through the paging channel pass through a convolutional encoder 224, a symbol repeater 226 and a block interleaver 228 and passes through an exclusive OR gate 236 together with an output of a long code generator 232 generated by a long code mask 230. The data through the exclusive OR gate 236 is then transmitted to the spreading and modulation block of FIG. 3.

A traffic channel 240 in FIG. 2b is a channel dedicatedly allocated to each secondary communication station for use until the call is completed. When there are data to be transmitted to each secondary communication station, the primary communication station transmits the data through the traffic channel 240. The data from the traffic channel 240 passes through a cyclic redundancy check (CRC) bit attachment block 241 for detecting errors in a specific time unit, or frame, (e.g. 20ms in IS-95). Tail bit attachment

block 242 are inserted into the traffic channel, all of which are “0”, and the data through the CRC 241 pass through a convolutional encoder 244 for ensuring to independently encoding the channel in a frame unit. The data then pass through a symbol repeater 246 for matching its transmitting symbol rate according to a transmitting data rate. After passing through the symbol repeater 246, the data pass through a block interleaver 248 for changing an error burst into a random error. The data passing through the block interleaver 248 are scrambled in a scrambler 256 with use of a pseudo-noise (PN) sequence, generated by passing an output of a long code generator 232 decimated in a decimator 234 with use of a long code mask 250 generated by an electronic serial number (ESN) allocated to each secondary communication station.

A PCB (Power Control Bit) position extractor 258 extracts a position where a command for controlling transmission power from the secondary communication station is inserted in the PN sequence decimated in the decimator 234. A puncturing and inserting block 260 punctures an encoded data symbol corresponding to the inserting position of the power control command extracted by the PCB position extractor 258 among the data symbols scrambled in the scrambler 256 and inserts the power control command, then transmitting the power control command to the spreading and modulation block in FIG. 3.

According to the present invention, the location of the

data symbol for multiplexing transmission hopping time can also be determined by using the PN sequence decimated as shown above.

FIGs. 3a, 3b and 3c show an embodiment of a spreading and modulation block according to the prior art.

FIG. 3a corresponds to the commonly used IS-95 system employing BPSK (Binary Phase Shift Keying) as a data modulation method.

FIG. 3b shows the case for spreading I/Q channel transmitting data by employing a different orthogonal code symbol in FIG. 3a.

FIG. 3c shows the spreading and modulation block employing QPSK (Quadrature Phase Shift Keying) as a data modulation method for transmitting double data rate in comparison to the method in FIG. 3a. FIG. 3c is adapted in the cdma2000® system, which is one of candidate techniques for the IMT-2000 system.

FIG. 3d shows the spreading and modulation block employing QPSK (Quadrature Phase Shift Keying) as a data modulation method for transmitting double data rate in comparison to the method in FIG. 3b.

FIG. 3e shows a spreading and modulation block, which employs QOC (Quasi-Orthogonal Code) used in cdma2000® system, which is one of candidate techniques for the IMT-2000 system.

FIG. 3f shows the case for spreading I/Q channel transmitting data by employing a different orthogonal code

symbol in FIG. 3e.

In FIG. 3a, signal converters 310, 330, 326, 346, 364 convert logical values “0” and “1” to physical signal “+1” and “-1” to be really transmitted. Each channel of FIG. 2 passes through the signal converters and is then spread in spreaders 312, 332 by an output of a Walsh code generator 362. Transmission power of each channel is adjusted in gain controllers 314, 334.

All channels from the primary communication station are spread in spreaders 312, 332 by an orthogonal Walsh function from the Walsh code generator 362 allocated to each channel fixedly. The channels are then gain-controlled in the gain controllers 314, 334 and then multiplexed 316, 336 based on orthogonal code division scheme. The multiplexed signals are scrambled at QPSK spreading and modulation blocks 318, 338 by a short PN sequence 324, 344 for the primary communication station identification. Low-pass filters (LPF) 320, 340 filter the spread and scrambled signals. The signal modulated by the carrier passes through a radio frequency (RF) processing block and is then transmitted through an antenna.

In FIG. 3b, signal converters 310, 330, 326, 346, 364, 365 convert logical values “0” and “1” into physical signal “+1” and “-1” to be really transmitted. Each channel of FIG. 2 passes through the signal converters and is then spread in spreaders 312, 332 by each output of two Walsh code generators 362, 363. Transmission power of each channel is

adjusted in gain controllers 314, 334.

All channels from the primary communication station are spread in spreaders 312, 332 by an orthogonal Walsh function of the Walsh code generators 362, 363 allocated to each channel fixedly. The channels are then gain-controlled in the gain controllers 314, 334 and then are multiplexed 316, 336 based on the orthogonal code division scheme. The multiplexed signals are scrambled at QPSK scrambling blocks 318, 338 by a short PN sequence 324, 344 for the primary communication station identification. Signals spread and scrambled are filtered by low-pass filters (LPF) 320, 340. The signal modulated by the carrier passes through a radio frequency (RF) processing block and is then transmitted through an antenna.

FIG. 3c is identical to FIG. 3a except the fact that, in order to transmit the signal generated in FIG. 2 to QPSK instead of BPSK, different information data are carried in an in-phase channel and a quadrature phase channel through a demultiplexer 390. Using the demultiplexer 390 and the signal converters 310, 330 enables QAM (Quadrature Amplitude Modulation) as well as QPSK.

FIG. 3d is identical to FIG. 3b except the fact that, in order to transmit the signal generated in FIG. 2 to QPSK instead of BPSK, different information data are carried in an in-phase channel and a quadrature phase channel through a demultiplexer 390.

FIG. 3e shows the case that a QOC mask is used for

distinguishing a channel from the primary communication station to the secondary communication stations in FIG. 3c. Orthogonality is not maintained in a code symbol group using different QOC masks but maintained in a code symbol group using same QOC mask. Therefore, the present invention is applied to the orthogonal code symbol group using the same QOC mask, which may maintain the orthogonality.

FIG. 3f like FIGs. 3b and 3d, is identical to FIG. 3e except the fact that, an independent Walsh code generator exists at I and Q channels in order to be able to spread I/Q channel transmitting data through a different orthogonal code symbol.

FIGs 4a, 4b and 4c is an example of signal diagram in order to explain the multiplexing method which transmits the signals by allocating orthogonal resource at each channel.

When a primary communication station communicates with its secondary communication stations, the transmission data rate transmitted to each secondary communication station can vary with respect to time. For instance, if the highest transmission rate per channel allocated to the secondary communication station by the primary communication station is a basic transmission rate (R), then the average transmission rate can be a variety of forms such as R, R/2, R/4, ..., and 0, according to the amount of data transmitted from the primary communication station to the secondary communication station at each frame.

FIG. 4a shows the case for matching an instant

transmission rate at each frame with the average transmission rate and this method is used in orthogonal code division multiplexing communication system for a forward link such as IS-95.

FIG. 4b illustrates the method for matching an instant transmission rate with the basic transmission rate at each frame by filling up the empty parts with dummy information when the transmitting data at each frame is less than the basic transmission rate.

FIG. 4c shows the method for adjusting the average transmission rate at the corresponding frame according to a rate between the intervals which possess R and 0 as the transmission rates where the instant transmission rate is either a basic transmission rate (R) or 0 (No transmission). The method used in FIG. 4c is not the transmission symbol based ON/OFF like the present invention, but time slot based ON/OFF. The time slot which is a power control period, is used for controlling the average transmission rate at each frame and at the same time maintaining a reference signal amplitude for closed loop power control of a reverse link in IS-95 system. In the IS-95 reverse link, unlike the present invention, the orthogonality between the channels is not guaranteed.

In FIGs 4a, 4b and 4c, a primary communication station transmits a common pilot channel to the secondary communication stations in parallel, however, since the pilot channel is used as a reference for synchronization, channel

tracking , phase estimation and power control, can be transmitted using the time division multiplexing method similar to the Wideband CDMA (W-CDMA) system for IMT-2000 system. In this case, the pilot channel according to the pilot symbol or location of multiplexing is called in various terms including a Preamble, Mid-amble and Post-amble.

FIG. 4d illustrates the frequency division multiplexing method according to the prior arts. A different frequency band is used as a communication channel between the primary communication station and each secondary communication station. The frequency division multiplexing method according to the present invention includes the Orthogonal Frequency Division Multiplexing (OFDM) method of which has been extensively studied for the purpose of a satellite broadcasting. For the case of OFDM, the frequency band for each subcarrier channel is in an overlapped state which has not been completely separated. However, it can be included in the orthogonal resource of the present invention since the orthogonality between the subcarriers is guaranteed.

FIG. 4e illustrates the conventional time division multiplexing method such as the GSM system. The same frequency band is used as a communication channel between the primary communication station and each secondary communication station. However, each time slot within the frame is wholly allocated to the corresponding secondary communication station.

FIGs. 4f, 4g and 4h show an implementation of the

frequency hopping method on the conventional frequency division multiplexing method, as shown in FIG. 4d, in order to improve the frequency diversity and security.

FIG. 4f shows the frequency hopping pattern on a time slot basis.

FIG. 4g shows the regular frequency hopping pattern based on a transmitting data symbol unit.

FIG. 4h shows the irregular frequency hopping based on a transmitting data symbol unit.

FIG. 4g illustrates a method that focuses on frequency diversity and FIG. 4h shows a method that emphasizes the security on frequency diversity and protection against the eavesdropping from any unauthorized receivers. In the frequency hopping multiplexing, there exists a fast frequency hopping multiplexing method based on a symbol and part-symbol unit as well as a slow frequency hopping multiplexing method based on a few symbol units.

The methods shown in FIGs. 4f, 4g and 4h can provide the frequency diversity by implementing the time division multiplexing method in FIG. 4e. In reality, the use of the time slot and frequency hopping based on a frame unit for strengthening of the frequency diversity instead of security enhancement in the second generation mobile communication system such as Global System for Mobile (GSM) is optional.

FIG. 4i illustrates the conventional orthogonal code division multiplexing such as IS-95, cdma2000® and W-CDMA. The communication channels between the primary

communication station and its secondary communication stations use the same frequency band and all time slots within the frame. The primary communication station allocates a fixed orthogonal code symbol on each channel at the time of a call establishment, and at the time of a call completion, reallocates the released orthogonal code symbol to one of other secondary communication stations where a new call is being requested. Hence, all data symbols within a frame are spread by the same orthogonal code symbol. The configuration of the transmitter of the primary communication station which corresponds to FIG. 4i is given in FIGs. 3a, 3b, 3c, 3d, 3e and FIG. 3f.

The configuration of a receiver of the secondary communication station, corresponding to the transmitter of the primary communication station according to an embodiment of the prior art given in FIG. 4i, is similar except the despreading parts for FIGs. 3a, 3b, 3c, 3d, 3e and FIG. 3f. Hence, FIG. 5 briefly describes the configuration of a receiver corresponding to the configuration of the transmitter in FIG. 3a.

The signal received through the antenna passes through multipliers 510, 530 for demodulating the signal with a carrier, low pass filters (LPFs) 512, 532 for extracting baseband signal and short code generators 520, 540 for descrambling the signal with a sequence same as the PN sequence used in the transmitter. The signal then passes through multipliers 514, 534 for descrambling the received

signal and then despreaders 516, 536 for accumulating the signals during a transmission data symbol area. A channel estimator 550 estimates a transmission channel by extracting only pilot channel components from the received signal. A phase recovery 560 compensates for phase distortion of the received signal using an estimated phase. If the pilot channel is time division multiplexed instead of code division multiplexed, then only pilot channel components are extracted by a demultiplexer and the phase changes between intermittent pilot signals can be estimated by interpolation.

FIG. 6 shows a configuration of a receiver for a channel such as paging channel in which a control command for controlling transmission power from the secondary communication station to the primary communication station is not included. Referring to the figure, maximum ratio combiners 610, 612 combine signals passing through the phase compensation to a maximum ratio. If the transmitter performs QPSK data modulation as shown in FIG. 3b, the receiver performs descrambling by multiplexing the signal in a multiplexer 614, performing soft decision in a soft decision unit 616, then decimating an output of a long code generator 622 generated by a long code mask 620 in a decimator 624, and then multiplying the signal through the soft decision unit with a decimated result of the decimator 624. In the present invention, a configuration of a receiver in the secondary communication station for the orthogonal code hopping multiplexing is similar to the configuration in FIG. 6. For the

synchronization channel, the descrambling processes 620, 622, 624, 626, 628 using the long code may be skipped.

FIG. 7 shows a configuration of a receiver for a traffic channel in which a control command for controlling transmission power of the secondary communication station is included. As shown in the figure, the phase-compensated signal passes through maximum ratio combiners 710, 712. In case that a receiver performs QPSK data demodulation as shown in FIG. 5, a multiplexer 714 multiplexes an in-phase component and a quadrature phase component in the signal. An extractor 740 extracts a signal component corresponding to the power control command transmitted from the primary communication station among the received signal. The signal from the extractor 740 then passes through a hard decision unit 744 and is then transmitted to a transmission power controller of the secondary communication station. Data symbols except the power control command in the received signal from the multiplexer 714 pass through a soft decision unit 742. A decimator 724 decimates an output of a long code generator 722 generated by a long code mask 720 generated by an identifier of the secondary communication station. The data symbols from the soft decision unit 742 is then multiplied in a multiplier 718 by a result of the decimator 724, so to perform descrambling.

FIG. 8 shows a function of recovering the received signal through the signal processing of FIGs. 6 and 7 from the primary communication station, through block deinterleavers

818, 828, 838 and convolutional decoders 814, 824, 834. In a synchronizaton channel 810, in order to lower a symbol rate, a sampler 819 performs symbol compression for the signals through the soft decision unit by accumulating the signals, which is an inverse process to the symbol repeater 219. The signal through the sampler 819 passes through a block deinterleaver 818. Then, a sampler 816 performs symbol compression again for the signal, which is an inverse process to the symbol repeater 216, before the signal passes to a convolutional decoder 814. The signal after the symbol compression then passes through the convolutional decoder 814, then the data of synchronization channel transmitted from the primary communication station are recovered. In case of a paging channel 820, the signal after the soft decision passes through a block deinterleaver 828 for channel deinterleaving. The channel-deinterleaved signal passes through a sampler 826 for symbol compression according to the transmitting data rate, which is an inverse process of the symbol repeater 226. The signal after the symbol compression passes through a convolution decoder 824 for channel decoding, so the paging channel transmitted from the primary communication station is recovered.

In case of a traffic channel 830, the signal after the soft decision passes through a block deinterleaver 838 for performing channel deinterleaving regardless of a transmitting data rate. The channel-deinterleaved signal passes through a sampler 836 for performing symbol compression according to

the transmitting data rate, which is an inverse process to the symbol repeater 246. A convolutional decoder 834 performs channel decoding for the signal after the symbol compression. A tail bit remover 832 removes tail bits of the signal used for independent transmission signal generation in a frame unit. A CRC 831 generates a CRC bit for the transmitting data portion like the transmitter and checks errors by comparison with a recovered CRC after channel decoding. If the two CRC bits coincide, the CRC 831 determines that there is no error and then the traffic channel data are recovered. If the transmitter does not include information about the transmitting data rate in 20ms frame unit, the transmitting data rate of the primary communication station may be determined by channel-decoding the signals after the independent channel deinterleaving and comparing the CRC bits. A system, which transmits a transmitting data rate independently, just further requires a channel decoding process corresponding to the data rate.

As shown in FIG. 1, the conventional methods used for maintaining the orthogonality between the channels from the primary communication station to the secondary communication station can be classified into four different types.

First, as shown in FIG. 4d, using a frequency division multiplexing method which fixedly allocates an available frequency band of the primary communication station to a secondary communication station at the time of a call

establishment.

Second, as shown in FIG. 4e, using a frequency division multiplexing method which fixedly allocates a time slot of the primary communication station to a secondary communication station at the time of a call establishment.

Third, as shown in FIGs. 4f, 4g and FIG. 4h, allocating a controlled frequency hopping pattern to the secondary communication station in order to avoid a frequency selective fading at the time of a call establishment or using a total bandwidth consisted of several sub-carriers in a single secondary communication station at a given time and place like in a military use.

Fourth, as shown in FIG. 4i, spreading the channel to the secondary communication station by allocating an available orthogonal code symbol to the secondary communication station at the time of a call establishment.

Among the four methods described, the common point for the rest of three methods excluding the frequency hopping multiplexing is fixedly allocating orthogonal resources (frequency, time, orthogonal code) to the secondary communication station by the primary communication station. The frequency hopping multiplexing is also used in applications with a sufficient amount of resources mainly for the purpose of security. Therefore, it is not subjected to an efficient use of the resources. Hence, in a case where this method is used, a fixed allocation of a limited orthogonal resources to a channel with a relatively low activity or a

variable channel with a transmitting data rate which is lower than the basic transmission rate, makes an efficient use of the resources very difficult.

Therefore, while the prior art allocates the orthogonal resources such as frequency, time and orthogonal code in a fixed manner so as to have a one-to-one relationship between the orthogonal resource and the channel, the present invention, with a little modification of the prior art, performs statistical multiplexing for traffic channels having low activities in consideration of activity of the transmitting data in order to increase the number of channels from the primary communication station to the secondary communication station and the activities of the orthogonal codes, which are limited resources, and eliminates unnecessary channel allocation and release processes in order to decrease buffer capacity required by the primary communication station, data transmission delay and achieves a seamless handoff to the adjacent cells

DISCLOSURE OF INVENTION

As shown in the conventional method, in order to increase the utilization of orthogonal resources with fixed allocation, fast channel allocation and release scheme are required. However, if transmitting the control signal information for channel allocation and de-allocation (release) occur more frequently, a significant amount of limited

frequency resources should be used for the control information of data transmission, not for data transmission itself. Moreover, fast channel allocation and de-allocation (release) are processed. Because of long round trip delay of channel allocation and de-allocation (release) command there should be a longer buffering in the primary communication station after the data to be transmitted. If more time for such processes is required, larger buffer size is required in the primary communication station. Information, which requires checking whether the information is transmitted normally, should be buffered for retransmission. However, in case of transmitting information without checking normal transmission of the information, such as, in a datagram method, delay should be minimized in an available range in order to decrease the capacity of the buffer.

The present invention is designed to overcome the above problems of the prior art. One objective of the invention is to provide a multiplexing method and apparatus, to perform statistical multiplexing for traffic channels having low activities in consideration of activity of the transmitting data in order to increase the number of channels from the primary communication station to the secondary communication station and the activities of the orthogonal codes, which are limited resources, and eliminates unnecessary channel allocation and de-allocation in order to decrease buffer capacity requested by the primary communication station, data transmission delay and achieves a seamless handoff to

adjacent cells. The present invention utilizes a statistical multiplexing called as multi-dimensional orthogonal code hopping multiplexing which takes frequency, time and orthogonal code as an orthogonal axis in case when the activity of the synchronized channels which maintains orthogonality is low or when the transmitting data rate of the channels vary at the lower rate than the basic transmission rate.

In order to accomplish the above objective, the present invention provides a multiplexing method and apparatus wherein orthogonal resources are pseudo-randomly allocated to the encoded data symbols on the basis of statistical characteristics required by the service to the channels with a data channel that generates a relatively low traffic or the channels whose real transmitting data rate varies below the allocated basic transmitting data rate. As a result, the channels are multiplexed statistically by distinguishing the channels from multi-dimensional orthogonal resource hopping patterns. In order to protect from a faulty reception due to the collision of the multi-dimensional orthogonal resource coordinates which may occur from the independent and pseudo-random hopping pattern for each secondary communication station, the transmitting encoded data symbols for all channels involved in the collision are compared, and the transmission is halted unless all the transmitting data coincide. At the same time, in order to compensate for the average received bit energy, the

transmission energy from the primary communication station to the secondary communication station can be increased for a specific amount and duration.

Moreover, the method proposed in the present invention can coexist with the conventional system by separately operating the collection of resources used in multi-dimensional orthogonal resource hopping multiplexing from the collection of resources used in the conventional method since all the resources maintain orthogonality.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a system concept diagram illustrating the primary communication station and the secondary communication stations according to the embodiments of the prior arts and the present invention.

FIG. 2a illustrates a configuration of transmitter corresponding to the common configuration elements according to the embodiments of the prior arts and the present invention.

FIG. 2b shows a configuration of traffic channel transmitter of the primary communication station according to the embodiments of the prior arts.

FIG. 3a illustrates a configuration of transmitter of the primary communication station based on the code division multiplexing method according to the embodiments of the prior arts (when it is BPSK modulated and uses the same

orthogonal code symbol for I/Q channels).

FIG. 3b shows a configuration of transmitter of the primary communication station on the code division multiplexing method according to the embodiments of the prior arts (when it is BPSK modulated and uses different orthogonal code symbols for I/Q channels).

FIG. 3c illustrates a configuration of transmitter of the primary communication station on the code division multiplexing method according to the embodiments of the prior arts (when it is QPSK modulated and uses the same orthogonal code symbol for I/Q channels).

FIG. 3d shows a configuration of transmitter of the primary communication station on the code division multiplexing method according to the embodiments of the prior arts (when it is QPSK modulated and uses different orthogonal code symbols for I/Q channels).

FIG. 3e illustrates a configuration of transmitter of the primary communication station that uses quasi-orthogonal codes according to the embodiments of the prior arts (when it is QPSK modulated and uses the same orthogonal code symbols for I/Q channels).

FIG. 3f shows a configuration of transmitter of the primary communication station that uses quasi-orthogonal codes according to the embodiments of the prior arts (when it is QPSK modulated and uses the same orthogonal code symbols for I/Q channels).

FIG. 4a illustrates a transmission signal diagram for

each frame of the primary communication station according to an embodiment of the prior arts

FIG. 4b shows a transmission signal diagram for each frame of the primary communication station according to other embodiment of the prior arts.

FIG. 4c illustrates a transmission signal diagram for each frame of the primary communication station according to another embodiment of the prior arts.

FIG. 4d shows a transmission signal diagram based on the frequency division multiplexing (FDM) according to the prior arts.

FIG. 4e illustrates a transmission signal diagram based on the time division multiplexing (TDM) according to the prior arts.

FIG. 4f shows a transmission signal diagram based on the time division multiplexing (TDM) according to the prior arts (implementing a frequency hopping based on slot unit).

FIG. 4g illustrates a transmission signal diagram based on the frequency division multiplexing (FDM) for frequency diversity according to the prior arts (regular frequency hopping method based on data symbol unit).

FIG. 4h shows a transmission signal diagram based on the frequency division multiplexing method (FDM) for frequency diversity and protection from eavesdropping according to the prior arts (irregular frequency hopping method based on data symbol unit).

FIG. 4i illustrates a transmission signal diagram based

on the orthogonal code division multiplexing (OCDM) method according to the prior arts (Fixed orthogonal code allocation for each channel).

FIG. 5 shows a configuration of a receiver of the secondary communication station based on the orthogonal code division multiplexing corresponding to a configuration of the transmitter in FIG. 4i.

FIG. 6 illustrates a common configuration of a receiver of the secondary communication station according to the embodiments of the prior arts and present invention.

FIG. 7 shows a configuration of a receiver of the secondary communication station according to the embodiments of the prior arts.

FIG. 8 illustrates a common configuration of a receiver of the secondary communication station according to the embodiments of the prior arts and present invention.

FIG. 9a shows a configuration of a transmitter of the primary communication station with the multiple traffic channels that are orthogonal resource hopping multiplexed and common physical control channels for the traffic channels according to the embodiments of the present invention.

FIG. 9b illustrates a signal diagram of common physical control channel (CPCCH) according to the embodiments of the present invention.

FIG. 10a shows a configuration of transmitter of the primary communication station based on the multi-dimensional orthogonal resource hopping multiplexing (MD-

ORHM) according to the embodiments of the present invention (corresponding to FIG. 3a).

FIG. 10b illustrates a configuration of transmitter of the primary communication station based on the multi-dimensional orthogonal resource hopping multiplexing (MD-ORHM) according to the embodiments of the present invention (corresponding to FIG. 3b).

FIG. 10c shows a configuration of transmitter of the primary communication station based on the multi-dimensional orthogonal resource hopping multiplexing (MD-ORHM) according to the embodiments of the present invention (corresponding to FIG. 3c).

FIG. 10d illustrates a configuration of transmitter of the primary communication station based on the multi-dimensional orthogonal resource hopping multiplexing (MD-ORHM) according to the embodiments of the present invention (corresponding to FIG. 3d).

FIG. 10e shows a configuration of transmitter of the primary communication station based on the multi-dimensional orthogonal resource hopping multiplexing (MD-ORHM) according to the embodiments of the present invention (corresponding to FIG. 3e).

FIG. 10f illustrates a configuration of transmitter of the primary communication station based on the multi-dimensional orthogonal resource hopping multiplexing (MD-ORHM) according to the embodiments of the present invention (corresponding to FIG. 3f).

FIG. 11 shows a configuration of a multi-dimensional hopping pattern generator according to the embodiments of the present invention.

FIG. 12a illustrates an example of sub-carrier group for frequency hopping according to the embodiments of the present invention (orthogonal code = frequency).

FIG. 12b shows a sub-carrier synthesizer according to the output of frequency hopping pattern generator according to the embodiments of the present invention.

FIG. 12c illustrates an example data symbol position for transmission time hopping based on a symbol unit according to the embodiments of the present invention (orthogonal resource = time, “1”= ON, “0” = OFF).

FIG. 12d shows a configuration of data symbol position selector (or buffer) according to the output of time hopping pattern generator in the transmitter of the primary communication station in the embodiments of the present invention.

FIG. 12e illustrates a configuration of orthogonal Gold code generator according to the orthogonal code hopping patterns in the embodiments of the present invention (orthogonal resource = orthogonal Gold code).

FIG. 12f shows a tree-structured orthogonal Walsh code according to several spreading factors (orthogonal resource = orthogonal Walsh code).

FIG. 12g illustrates a configuration of orthogonal Walsh code generator according to the orthogonal code hopping

patterns in the embodiments of the present invention (orthogonal resource = orthogonal Walsh code).

FIG. 12h shows a configuration of symbol position selector (or buffer) according to the output of time hopping pattern generator in the transmitter of the second communication in the embodiments of the present invention.

FIG. 13a illustrates a configuration of receiver of the secondary communication station based on the multi-dimensional orthogonal resource hopping multiplexing method according to the embodiments of the present invention in FIG 10a.

FIG. 13b shows a configuration of receiver of the secondary communication station based on the multi-dimensional orthogonal resource hopping multiplexing method according to the embodiments of the present invention in FIG 10b.

FIG. 13c illustrates a configuration of receiver of the secondary communication station based on the multi-dimensional orthogonal resource hopping multiplexing method according to the embodiments of the present invention in FIG 10c.

FIG. 13d shows a configuration of receiver of the secondary communication station based on the multi-dimensional orthogonal resource hopping multiplexing method according to the embodiments of the present invention in FIG 10d.

FIG. 13e illustrates a configuration of receiver of the

secondary communication station based on the multi-dimensional orthogonal resource hopping multiplexing method according to the embodiments of the present invention in FIG 10e.

FIG. 13f shows a configuration of receiver of the secondary communication station based on the multi-dimensional orthogonal resource hopping multiplexing method according to the embodiments of the present invention in FIG 10f.

FIG. 14a illustrates a transmission signal diagram from the primary communication station for each frame according to the embodiments of the conventional method.

FIG. 14b shows a transmission signal diagram from the primary communication station for each frame according to the embodiments of the present invention.

FIG. 14c illustrates a (regularly time-hopped) transmission signal diagram from the primary communication station in a frame (statistically coarse frame) whose transmission rate is below the basic transmission rate (R) according to the embodiments of the present invention.

FIG. 14d shows a (irregularly time-hopped) transmission signal diagram from the primary communication station in a statistically coarse frame according to the embodiments of the present invention.

FIG. 14e illustrates a (irregularly time-hopped) transmission signal diagram from the primary communication station by a frequency hopping multiplexing (FHM) in a

statistically coarse frame according to the embodiments of the present invention.

FIG. 14f shows illustrating a collision case (the square surrounded by double-line is a collided data symbol) which occurs due to a simultaneous selection of through multiple channels of the multi-dimensional hopping patterns that are represented in a two-dimensional coordinate in FIG. 14e (transmission time, sub-carrier).

FIG. 14g illustrates illustrating the final process to determine whether to transmit or not by comparing the transmitting data symbols where collisions occurred in FIG. 14f.

FIG. 14h shows a diagram of regularly time-hopped transmission signal from the primary communication station based on symbol units in a statistically coarse frame according to the embodiment of the present invention.

FIG. 14i illustrates a diagram of irregularly time-hopped transmission signal from the primary communication station based on symbol units in a statistically coarse frame according to the embodiment of the present invention.

FIG. 14j illustrates a collision case (the square surrounded by double line is a collided data symbol) that occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a one-dimensional coordinate in FIG. 14i (transmission time (or position of data symbol)).

FIG. 14k shows the final process to determine whether

to transmit or not (the squares filled with black color indicate a transmission and the empty squares surrounded by dashed line indicates no transmission) by comparing the transmitting data symbols where collisions occurred in FIG. 14j.

FIG. 141 illustrates a diagram of transmission signal from the primary communication station by the orthogonal code hopping multiplexing method in a basic transmission rate (R) frame (statistically dense frame) according to the embodiment of the present invention.

FIG. 14m shows a diagram of transmission signal from the primary communication station by the time division multiplexing based on slot units and orthogonal code hopping multiplexing in a statistically coarse frame according to the present invention.

FIG. 14n illustrates illustrating a collision case (the square surrounded by double line is a collided data symbol) that occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a one-dimensional coordinate in FIG. 14m (transmission time, orthogonal code).

FIG. 14o shows the final process to determine whether to transmit or not by comparing the transmitting data symbols where collisions occurred in FIG. 14n (the squares filled with black color indicate transmission and the empty squares surrounded by dashed line indicate no transmission).

FIG. 14p illustrates a transmission signal diagram (the first data symbol of a frame is located at an identical position)

from the primary communication station by a regular and periodic time division multiplexing based on a symbol unit and orthogonal code hopping multiplexing in a statistically coarse frame according to the present invention.

FIG. 14q shows a collision case (the square surrounded by double line is a collided data symbol) that occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a two-dimensional coordinate in FIG. 14p (transmission time, orthogonal code symbol).

FIG. 14r shows the final process to determine whether to transmit or not (the squares filled with black color indicate a transmission and the empty squares surrounded by dashed line indicate no transmission) by comparing the transmitting data symbols where collisions occurred in FIG. 14q.

FIG. 14s shows a transmission signal diagram (the first data symbol of a frame is located at a skewed position) of the primary communication station by a regular and periodic time division multiplexing based on a symbol unit and orthogonal code hopping multiplexing in a statistically coarse frame according to the present invention.

FIG. 14t illustrates a collision case (the square surrounded by double line is a collided data symbol) which occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a two-dimensional coordinate in FIG. 14s (transmission time, orthogonal code).

FIG. 14u shows the final process to determine whether to transmit or not (the squares filled with black color indicate a transmission and the empty squares surrounded by dashed line represent no transmission) by comparing the transmitting data symbols where collisions occurred in FIG. 14t.

FIG. 14v illustrates a diagram of transmission signal from the primary communication station by a irregular and periodic time division multiplexing based on a symbol unit and orthogonal code hopping multiplexing in a statistically coarse frame according to the present invention.

FIG. 14w illustrates a collision case (the square surrounded by double line is a collided data symbol) which occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a two-dimensional coordinate in FIG. 14v (transmission time, orthogonal code).

FIG. 14x shows the final process to determine whether to transmit or not (the squares filled with black color indicate a transmission and the empty squares surrounded by dashed line indicate no transmission) by comparing the transmitting data symbols where collisions occurred in FIG. 14w.

FIG. 15 in case of FIGs. 14g, 14o, 14r, 14u and 14x illustrates an increase in transmission power of the primary communication station for a specific interval after the data symbols which are not transmitted in order to satisfy the required quality and to compensate for the average received energy required by the channel decoder when the

transmission is temporarily halted in a collision interval of multi-dimensional hopping patterns.

FIG. 16 shows that the puncturing of encoded data symbol due to a collision of multi-dimensional hopping patterns and an inconsistency of data symbols is operated independently for each transmission antenna beam from the primary communication station.

* Description of the numeric on the main parts of the drawing

380: Multi-dimensional (orthogonal Resource) Hopping Pattern Generator

382: Orthogonal Code Generator according to multi-dimensional hopping patterns

384, 386: Hopping pattern Collision Detector, Data Symbol Comparator and Controller

388: Frequency synthesizer according to multi-dimensional hopping pattern

385, 387: Transmission Power Control Apparatus using the Controller

392, 393: Symbol position Selector (or Buffer) according to Multi-dimensional Hopping Pattern

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the

accompanying drawings.

In this application, the same reference numbers are used for components similar to the prior art and only modified or added components in comparison with the prior art are described for the present invention in detail.

The orthogonal code hopping multiplexing (OCHM) according to the present invention communicates by selecting an orthogonal code symbol with respect to the one-dimensional hopping pattern agreed between the primary communication station and a secondary communication station. In case of a collision, if the agreed one-dimensional hopping pattern between the primary communication station and a second communication is independent, all the data symbols belonging to the channels related to the collision are compared and transmitted when all of them are identical data symbols. Otherwise, the corresponding symbols are not transmitted by puncturing and the punctured parts of the data symbols are recovered from the receiver using a channel decoder (Korean Patent of Application Number 10-1999-032187, “Method and apparatus for orthogonal code hopping multiplexing communications”). The present invention is a statistical multiplexing method that generalizes the orthogonal code hopping method against all the orthogonal resources.

In the embodiments of the present invention, a primary communication station and the secondary communication station correspond to a base station and a mobile station,

respectively, in the existing commercialized mobile communication system. A single primary communication station communicates with a plurality of the secondary communication stations and the present invention provides a statistical multiplexing method that can be implemented in a group of synchronized channels with orthogonality from the primary communication station to the secondary communication station. Like Quasi-Orthogonal Code (QOC) that is adopted in the cdma2000® method which is one of candidate technologies for the next generation mobile communication system and Multi-Scrambling Code (MSC) adopted in the W-CDMA method, the method from the present invention can be independently implemented within the system where orthogonalilty is maintained in each channel group. Also, when the channels from the primary communication station are classified into a number of channel groups which possess the same transmission antenna beam like sectorization, switched beam or smart antenna system, the present invention can be independently implemented in each channel group.

FIG. 9a shows a configuration for multi-dimensional orthogonal resource hopping multiplexing for bursty channels and this configuration is identical except for the fact that puncturing and insertion of transmission control commands for the secondary communication station. For communication, there exist a two-way and one-way communication and for the one-way communication, there is no need for transmitting a

transmission power control commands to the secondary communication station. However, for two-way communication, there is a need for transmission power control in order to maximize system capacity through efficient power control. For fast processing, power control commands are not channel-encoded generally. For a pseudo-random orthogonal code hopping pattern, a collision between two different channels is inevitable. Hence, the power control command should be transmitted through a collision-free channel. For this purpose, the concept of common power control channel, from the cdma2000® method which is one of the candidates for IMT 2000 system, can be adopted in this specification and called here as Common Physical Control CHannel (CPCCH).

The Common Physical Control Channel like the pilot channel previously mentioned, is spread through a separate orthogonal code symbol and transmits a physical class control command by the time division multiplexing for a plurality of the secondary communication stations. The location for a power control command for each secondary communication station is allocated at the establishment of a call.

FIG. 9a illustrates an embodiment of the common physical control channels for controlling 24 secondary communication stations based on IS-95 system as an example. In case when the channel varies below the basic transmission rate (R) from the primary communication station to the secondary communication station and the information is determined to be transmitted without any collision along with

Rate Information (RI) for each frame, the information can be transmitted after being time division multiplexed similarly to the power control command of the secondary communication station. If the Rate Information is not transmitted, the receiver sequentially determines the rate information through the channel decoding and CRC test for all possible combinations. It is typical for all the possible combinations to be agreed between the primary communication station and secondary communication station before call establishment.

FIG. 9b shows a signal diagram of Common Physical Control Channel according to an embodiment of the present invention. There exists two different types such as the CPCCH of type #1 which transmits a transmission power control command only from the primary communication station to the secondary communication station and the CPCCH of type #2 which transmits the transmission data rate information of the primary communication station as well.

FIG. 10a illustrates an implementation of the present invention to the embodiment of the conventional method, as shown in FIG. 3a. For the statistical multiplexing using multi-dimensional orthogonal resource hopping multiplexing as proposed in the present invention, there is a need for a collision detector, data symbol comparator and a controller 384 that detects a collision of multi-dimensional hopping patterns which occurs due to independent hopping patterns from a multi-dimensional hopping pattern generator 380 and impose a proper control.

FIG. 11 shows an example of implementation for the multi-dimensional hopping pattern generator. The configuration shows a multi-dimensional hopping pattern generation scheme using a conventional PN sequence generator. The multi-dimensional hopping patterns can be generated through other methods.

The multi-dimensional hopping patterns can be one-dimensional hopping patterns such as (frequency), (transmission time (or symbol position)) and (orthogonal codes), or two-dimensional hopping patterns such as (frequency, transmission time), (frequency, orthogonal codes) and (transmission time, orthogonal codes), or three-dimensional hopping patterns (frequency, transmission time, orthogonal codes), or the like. At the system development stage, only some parts of orthogonal resources are allowed to be involved with the hopping and other orthogonal resources are implemented to be fixedly allocated based on the division method. Also, it can be implemented in such a way that all the orthogonal resources are allowed to be involved with the hopping multiplexing and then through the next control command. It can be controlled in such a way that some parts of orthogonal resources are allowed to be involved in the hopping multiplexing.

According to the multi-dimensional hopping pattern generator 380, a frequency synthesizer 388 for frequency hopping, buffers 392, 393 for transmission time hopping and an orthogonal code generator that generates orthogonal code

symbols for orthogonal code hopping are required.

The carriers or sub-carriers that are generated from the frequency synthesizer 388 differ in the number of bits that indicates a coordinate in the frequency axis of the outputs from the multi-dimensional hopping pattern generator 380 according to the number of the (sub)carriers that is used for frequency hopping, as shown in FIG. 12a. Among the outputs of the multi-dimensional hopping pattern generator 380, the signal corresponding to the frequency coordinate values is delivered to the frequency synthesizer 388 and according to the input values, a specified (sub-)carrier is generated.

In the multi-dimensional hopping pattern multiplexing method, since the carrier frequency for the frequency hopping changes, unlike time hopping and orthogonal code hopping where the carriers are not changed, a channel tracking and phase compensation is difficult from the receiver. Hence, like the multi-carrier type of cdma2000, it is convenient to carry out the frequency hopping multiplexing by converting the carriers involved in multi-carrier into hopping enabled carriers when basically multi-carriers are implemented and the channel tracking for each carrier is done independently in parallel.

Among the outputs of the multi-dimensional hopping pattern generator 380, the signal corresponding to the coordinate of the time axis is delivered to the buffers 392, 393 for transmission time hopping. The location of data transmission within the buffers is determined according to the

input values, as shown in FIG. 12c.

In FIG. 12c, "1" indicates the existence of transmitting data and "0" indicates the absence of transmitting data.

FIG. 12d shows an example of an implementation when the number of probable positions for the existence of transmitting data is 16 in FIG. 12c.

The transmission time hopping as a multi-dimensional hopping multiplexing method is carried out in transmission symbol unit rather than in frame or time slot by taking an instant transmission rate as the basic transmission rate (R) in order to maximize the statistical multiplexing and to conveniently track the communication channels to the secondary communication station. The hopping is carried out in symbol unit. It is relatively convenient to track the changes of the channels in the secondary communication station since the transmission symbols are distributed evenly in probability within a frame.

The orthogonal codes generated from the orthogonal code generator 382 can either be orthogonal gold codes that are generated by the orthogonal gold code generator in FIG. 12e or any other orthogonal codes that maintain orthogonality such as the Orthogonal Variable Spreading Factor of a hierarchical configuration that becomes a Walsh code with respect to a specified spreading factor.

Among the outputs of the multi-dimensional hopping pattern generator 380, if the coordinates of the orthogonal code axis is fixed, then this is an orthogonal code division

multiplexing method which is identical to the conventional method. By separating one orthogonal code into two orthogonal symbol groups, one orthogonal code symbol group is used for an orthogonal code division by a fixed allocation and the other is used for an orthogonal code hopping multiplexing by the hopping patterns. One of the two divided orthogonal symbol groups is orthogonal code hopping multiplexed using randomly selected patterns in order to avoid collisions between the hopping patterns and the other orthogonal code symbol group is orthogonal code hopping multiplexed by the statistical multiplexing using independent hopping patterns between the channels with a possibility of hopping pattern collisions.

In both cases, the former is allocated when either the transmitting data is important or the activity of channel is high, and the latter can gain a statistical advantage by allocating to a channel that generates a relatively bursty traffic.

In case that hierarchical orthogonal codes which assist the variable spreading advantage are used as spreading codes shown in FIG. 12f, it is convenient to divide an orthogonal code into an orthogonal code symbol group that consists of child code symbols which possess the same parents symbols 391, 395 such as “01” or “0110” when dividing the orthogonal codes.

As briefly mentioned previously, for the case when the multi-dimensional hopping pattern generator 380 generates

multi-dimensional hopping patterns randomly in order for two different channels not to select an identical resource at the same time for each channel, no collision occurs. However, with this method, no multi-dimensional hopping patterns can be determined by the secondary communication station and the multi-dimensional hopping patterns should be allocated at the time of a call establishment by the primary communication station. Also, the number of multi-dimensional hopping patterns that can be allocated by the primary communication station are constrained by the number of the orthogonal resources and in case when a handoff occurs at the adjacent cell, a new multi-dimensional hopping pattern should be allocated from the adjacent cell.

The purpose of allocating multi-dimensional hopping patterns between the channels toward the secondary communication station without any collisions is not for statistical multiplexing but for attaining the gain from the diversity.

If the channels toward the secondary communication station have a high activity with statistically dense or non-bursty traffic, then it is more efficient to operate without any statistical multiplexing. However, according to the service characteristics, if the channels toward the secondary communication station have a low activity with statistically coarse or bursty traffic, the resources could be wasted. Therefore, independent multi-dimensional hopping patterns are generated in order to attain the gain from statistical

multiplexing and time diversity according to the data activity of each channel.

As a result, collisions between the multi-dimensional hopping patterns where two different channels select an identical multi-dimensional resource coordinate at the same time inevitably occur. Hence, in order to resolve these problem in the present invention, the occurrence of a collision between the hopping patterns is determined with a collision detector and controller 384, 386 by receiving all the hopping patters and data symbols to be transmitted for all channels.

All the multi-dimensional hopping patterns for each secondary communication station are generated within the primary communication station and all the data to be transmitted in each secondary communication station pass through the primary communication station. Therefore, whether the multi-dimensional hopping patterns collide or not and whether the transmitting data is identical or not can be ascertained.

All the data symbols from all the channels, corresponding to the case when multi-dimensional hopping patterns collide, are compared and if all the transmitting data symbols are identical, then the data symbols during the colliding interval are transmitted. This is because no errors occur during a channel decoding process for corresponding secondary communication station but even if one the symbols is not identical then the data symbols between the colliding interval of the corresponding channel are not transmitted. To

be more specific, according to the results from the collision detector and comparator 384, 386, the inputs for multiplier 385 and 387 become "+1" or "0". The transmission stops for the interval where the input for the multiplier is "0". In order to compensate for the lack of the average receiving energy of the secondary communication station required by the puncturing of the spread data symbols to satisfy the quality, the transmission power of the primary communication station is increased by controlling the gain of amplifiers 315, 335 of the corresponding channel in an amount and interval which is given as a system parameter like 1072 and 1074 in FIG. 15. Separately, the transmission power control of the primary communication station by the secondary communication station according to the conventional method can also be carried out.

FIG. 10b shows an implementation method for implementing the present invention to the embodiment of the conventional method in FIG. 3b.

It is identical to FIG. 10a except that independent multi-dimensional hopping patterns are generated at Identical Phase channel (I) and Quadrature Phase channel (Q) of the multi-dimensional hopping pattern generator 380. For the statistical multiplexing using multi-dimensional orthogonal resource hopping as proposed in the present invention, a multi-dimensional hopping pattern generator 380 and a collision detector and controller 384, 385 that determines the independent collision and transmission status for the I/Q

channels are required.

FIG. 10c shows a diagram for implementing the present invention to the embodiment of the conventional method in FIG. 3c.

It is identical to FIG. 10a except that the transmitting data to the I and Q channel is different since it modulates QPSK data unlike FIG. 10a which modulates BPSK data.

FIG. 10d shows a diagram for implementing the present invention to the embodiment of the conventional method in FIG. 3d

It is identical to FIG. 10c except that independent multi-dimensional hopping patterns are generated at the Identical Phase channel (I) and Quadrature Phase channel (Q) of the multi-dimensional hopping pattern generator 380. For the statistical multiplexing using multi-dimensional orthogonal resource hopping as proposed in the present invention, a multi-dimensional hopping pattern generator 380 and a collision detector and controller 384, 385 that determines the independent collision and transmission status for the I/Q channels are required.

FIG. 10e illustrates a diagram for implementing the present invention to the embodiment of the conventional method in FIG. 3e.

It is identical to FIG. 10c except that it is using a Quasi-Orthogonal Code (QOC).

FIG. 10f shows a diagram for implementing the present invention to the embodiment of the conventional method in

FIG. 3f.

It is identical to FIG. 10d except that it is using a Quasi-Orthogonal Code (QOC).

In FIG. 13a the signals from the primary communication station, which are received from an antenna, are demodulated 510, 530 by a frequency synthesizer 588 that is controlled by a multi-dimensional hopping pattern generator 580 and pass through a low power filter 512, 532. The low power filtered signals are descrambled 522, 542 using the scrambling codes 520, 540 which are identical to the receiver side and the orthogonal code symbols, generated 582 according to the coordinates of the orthogonal code axis which are delivered by the multi-dimensional hopping pattern generator 580 which is synchronized with the transmitter of the primary communication station, are multiplied 514, 534 and despread by integrating 516, 536 for the corresponding symbol interval. With the despread signals a non-coherent demodulation is carried out by compensating for the phase difference through a channel estimator. The compensated data symbols are delivered to the buffers 592, 593 by matching them with the coordinates of the transmission time axis of the multi-dimensional hopping pattern generator.

Since the transmitter for the primary communication station in FIG.10a performs a BPSK data modulation, the corresponding transmitter for the secondary communication station in FIG. 13a adds the received data from the I and Q channels that possess identical information. If independent

interleavers exist for each of the I and Q channels in the transmitter of the primary communication station in order to provide time diversity, then they first pass through a deinterleaver and the transmitting data from the I and Q channels are added.

FIG. 13b illustrates a configuration of the receiver in the secondary communication station for the orthogonal resource hopping multiplexing method according to the present invention in FIG. 10b. It is identical to FIG. 13a except that there exist an independent code generator 582, 584 for each of the I and Q channels.

FIG. 13c shows a configuration of the receiver in the secondary communication station for the orthogonal resource hopping multiplexing method according to the present invention in FIG. 10c. It is identical to FIG. 13a except that since the transmitter for the primary communication station in FIG.10c performs a QPSK data modulation, the corresponding transmitter for the secondary communication station in FIG. 13c does not add the received data from the I and Q channels that possess different information.

FIG. 13d illustrates a configuration of the receiver in the secondary communication station for the orthogonal resource hopping multiplexing method according to the present invention in FIG. 10d. It is identical to FIG. 13c except that there exist an independent code generator 582, 584 for each of the I and Q channels.

FIG. 13e shows a configuration of the receiver in the

secondary communication station for the orthogonal resource hopping multiplexing method according to the present invention in FIG. 10e. It is identical to FIG. 13e except that it despreads by using a quasi-orthogonal code 566.

FIG. 13f illustrates a configuration of the receiver in the secondary communication station for the orthogonal resource hopping multiplexing method according to the present invention in FIG. 10f. It is identical to FIG. 13e except that there exist an independent code generator 582, 584 for each of the I and Q channels.

FIG. 14 shows a concept diagram for a transmission signal from the primary communication station according to the embodiment of the present invention.

FIG. 14a is identical to the transmission signal diagram in the primary communication station for each frame according to the embodiment of the conventional method in FIG. 4a. The transmission rate for each frame for the channels from the primary communication station to the second communication varies below the basic transmission rate (R) like 920, 930 according to the service characteristics or repeats transmission(ON) and no transmission (OFF) at the basic transmission rate (R) like 940,950. The channels like 920, 930 can be represented in a channel activity diagram. In the present invention, a transmission time hopping multiplexing is attempted to the channels 920, 930 like 924, 934 in FIG. 14b according to the transmitting data rate for each frame. The transmission time hopping is implemented

with the same method in FIG. 12d.

FIGs. 14c and 14d illustrate how the hopping transmission time can be determined in reality with respect to the transmitting data rate for each frame. FIG. 14c shows a regular and periodic hopping. FIG. 14d illustrates an irregular and arbitrary hopping. FIG. 14c is advantageous for time diversity and channel tracking but is inappropriate for statistical multiplexing.

The method in FIG. 14d is useful for statistical multiplexing although a collision might occur if independent multi-dimensional hopping patterns are used for each frame.

FIG. 14e shows a method which takes a Frequency Hopping Multiplexing Method (FHM) and a Time Hopping Multiplexing Method in parallel in a statistically coarse frame according to the embodiment of the present invention. The secondary communication station can be distinguished by the pattern in the square.

FIG. 14f illustrates a collision case which occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a two-dimensional coordinate in FIG. 14e (transmission time, sub-carrier). The squares whose boundary are represented by a paired dot line indicate the location of data symbols where multi-dimensional hopping patterns are collided and the squares whose boundary are represented by a single dot line indicate the location of data symbols where no collision occurs.

FIG. 14g shows the final process to determine whether

to transmit or not by comparing the transmitting data symbols where collisions occur in FIG. 14f. The squares filled with black color indicate transmission even though collisions occurred for multi-dimensional hopping patterns. All data symbols of the channels involved in the collisions are identical and the empty squares surrounded by dashed line indicate no transmission since all data symbols of the channels involved in the collisions are not identical.

FIG. 14h shows a diagram of transmission signal from the primary communication station by the time division multiplexing method based on symbol units in a statistically coarse frame according to the embodiment of the present invention. It is a time division multiplexing based on symbol units that are evenly distributed in a frame unlike a time division multiplexing based on slot units that are concentrated between a specific interval, as shown in FIG. 4e. Therefore, time diversity can be attained. When the hopping patterns in an example embodiment of the present invention are periodic and used for diversity rather than statistical multiplexing, there exist no channel independence toward the secondary communication stations, and at the time of a call establishment the result of allocation from the primary communication station to the other secondary communication stations should be referenced. Hence, the time division multiplexing based on symbol units in FIG. 14h is advantageous when the instantaneous transmission rate is fixed.

FIG. 14i unlike FIG. 14h, illustrates a pseudo-random selection of a transmitting data symbol interval of the channel toward the secondary communication station in order to attain statistical multiplexing. The transmission time hopping patterns in the secondary communication station are independent.

FIG. 14j shows a collision case which occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a one-dimensional coordinate in FIG. 14i (transmission time). The squares whose boundary are represented by a paired dot line indicate the location of data symbols where multi-dimensional hopping patterns collide and the squares whose boundary are represented by a single dot line indicate the location of data symbols where no collision occur.

FIG. 14k illustrates the final process to determine whether to transmit or not by comparing the transmitting data symbols where collisions occur in FIG. 14j. The squares filled with black color indicate a transmission even though collisions occurred for multi-dimensional hopping patterns, all data symbols of the channels involved in the collisions are identical and the empty squares surrounded by dashed line indicate no transmission since all data symbols of the channels involved in the collisions are not identical.

FIG. 14l illustrates a special case orthogonal code hopping multiplexing where an orthogonal code that spreads the transmitting data symbol band of the channel toward the

secondary communication station is pseudo-randomly selected in order to attain statistical multiplexing. The orthogonal code hopping patterns toward the secondary communication station are independent. This method is explained in detail in the previous filed patent application on an orthogonal code hopping multiplexing method and apparatus (Korean patent of application number 10-1999-0032187) by the same inventor.

FIG. 14m shows a diagram of transmission signal to the secondary communication station where the time division multiplexing based on slot units according to the present invention and the orthogonal code hopping multiplexing coexist. In order to attain statistical multiplexing, the transmission time slots for the channel toward the secondary communication station and the orthogonal code symbols for spreading each transmitting data symbol are pseudo-randomly selected. The two-dimensional hopping patterns (transmission time, orthogonal code) are used for each secondary communication station.

FIG. 14n illustrates a collision case which occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a one-dimensional coordinate in FIG. 14m (transmission time, orthogonal code). The squares whose boundary are represented by a paired dot line indicate the location of data symbols where multi-dimensional hopping patterns collide and the squares whose boundary are represented by a single dot line indicate the location of data symbols where no collision

occurs.

FIG. 14o shows the final process to determine whether to transmit or not by comparing the transmitting data symbols where collisions occur in FIG. 14n. The squares filled with black color indicate transmission even though collisions occur for multi-dimensional hopping patterns, all data symbols of the channels involved in the collisions are identical and the empty squares surrounded by dashed line indicate no transmission since all data symbols of the channels involved in the collisions are not identical.

FIG. 14p illustrates a diagram of transmission signal from the primary communication station where the time division multiplexing in FIG. 14h and the orthogonal code hopping multiplexing in FIG. 14l coexist. As mentioned previously, even if FIG. 14h shows a configuration where no statistical multiplexing gain is attained, by implementing the orthogonal code hopping multiplexing method in FIG. 14l, a statistical multiplexing is attained. Irrespective of the transmission rate at each channel, the location of the first transmission symbols toward all secondary communication stations are identical. The orthogonal code symbols for band spreading of each transmitting data symbol toward the secondary communication station are pseudo-randomly selected. The first hopping patterns (orthogonal code) toward the secondary communication station are independent.

FIG. 14q shows a collision case that occurs due to a simultaneous selection through multiple channels of the

multi-dimensional hopping patterns that are represented in a one-dimensional coordinate in FIG. 14p (orthogonal code). The squares whose boundary are represented by a paired dot line indicate the location of data symbols where multi-dimensional hopping patterns collide and the squares whose boundary are represented by a single dot line indicate the location of data symbols where no collision occur.

FIG. 14r illustrates the final process to determine whether to transmit or not by comparing the transmitting data symbols where collisions occur in FIG. 14q. The squares filled with black color indicate transmission even though collisions occur for multi-dimensional hopping patterns, all data symbols of the channels involved in the collisions are identical and the empty squares surrounded by dashed line indicate no transmission since all data symbols of the channels involved in the collisions are not identical.

FIG. 14s shows a variation on time division and orthogonal code hopping multiplexing in FIG. 14p. The primary communication station allocates the locations of the first data symbol to the secondary communication station skewed in order to maintain the balance of the transmission power. Like FIG. 14p, the orthogonal code symbols for spreading each transmitting data symbol for the channel toward the secondary communication station are pseudo-randomly selected. The one-dimensional hopping patterns for the second communication (orthogonal code) are independent.

FIG. 14t illustrates a collision case that occurs due to a

simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a one-dimensional coordinate in FIG. 14s (orthogonal code). The squares whose boundary are represented by a paired dot line indicate the location of data symbols where multi-dimensional hopping patterns collide and the squares whose boundary are represented by a single dot line indicate the location of data symbols where no collision occur.

FIG. 14u shows the final process to determine whether to transmit or not by comparing the transmitting data symbols where collisions occur in FIG. 14t. The squares filled with black color indicate transmission even though collisions occur for multi-dimensional hopping patterns, all data symbols of the channels involved in the collisions are identical and the empty squares surrounded by dashed line indicate no transmission since all data symbols of the channels involved in the collisions are not identical.

FIG. 14v illustrates a diagram of transmission signal from the primary communication station where the time division multiplexing in FIG. 14i and the orthogonal code hopping multiplexing in FIG. 14l coexist. It is a composite statistical multiplexing method where it attains a statistical multiplexing gain through the time hopping multiplexing in FIG. 14i and at the same time, by implementing the orthogonal code hopping multiplexing method in FIG. 14l, statistical multiplexing is attained. The orthogonal code symbols for band spreading of each transmitting data symbol

toward the secondary communication station are pseudo-randomly selected. The first hopping patterns (orthogonal code) toward the secondary communication station are independent. The transmission time within a frame and the orthogonal code symbols for a band-spreading of each transmitting data symbol for the channel toward the secondary communication station are pseudo-randomly selected. The two-dimensional hopping patterns for the second communication (orthogonal code, orthogonal code) are independent.

FIG. 14w shows a collision case which occurs due to a simultaneous selection through multiple channels of the multi-dimensional hopping patterns that are represented in a one-dimensional coordinate in FIG. 14v (transmission time, orthogonal code). The squares whose boundary are represented by a paired dot line indicate the location of data symbols where multi-dimensional hopping patterns collide and the squares whose boundary are represented by a single dot line indicate the location of data symbols where no collision occur.

FIG. 14x illustrates the final process to determine whether to transmit or not by comparing the transmitting data symbols where collisions occur in FIG. 14w. The squares filled with black color indicate transmission even though collisions occur for multi-dimensional hopping patterns, all data symbols of the channels involved in the collisions are identical and the empty squares surrounded by dashed line indicate no

transmission since all data symbols of the channels involved in the collisions are not identical.

Statistical multiplexing using three-dimensional hopping patterns (frequency, transmission time, orthogonal code) by extending the statistical multiplexing using two-dimensional hopping patterns (transmission time, orthogonal code) are shown in FIG. 14v. Statistical multiplexing using an N-dimensional orthogonal resource hopping multiplexing method of (first orthogonal resource, second orthogonal resource, ..., N-th orthogonal resource) by extending the method proposed in the present invention is a step further. The gain from the statistical multiplexing using the multi-dimensional orthogonal resource hopping multiplexing can be inferred from the probability of a collision for the multi-dimensional hopping patterns and the probability of the corresponding transmitting data being not transmitted. Depending on what channel coding is used, the possibility of recovery of the data symbols that are not transmitted is different.

If the channels toward the secondary communication station that are the main concern of the present analysis contains no information, the analysis becomes meaningless. Hence, the analysis here only focuses on the channels which contain information.

Assumption: M= Total number of channels allocated by the primary communication station

α = Channel Activity (= average transmission rate per frame / basic transmission rate)

π_i = Probability of data symbol i to be transmitted

where $i \in \{0, 1, 2, \ldots\ldots, s-1\}$ and s = Number of data symbols

Example) For 8PSK, s = 8

For 16QAM, s = 16

1)Frequency Hopping Multiplexing

Assumption: c_1 = Total number of sub-carriers of frequency axis in multi-dimensional hopping patterns

(1) Collision Probability of Hopping Patterns

[Equation 1]

$$\sum_{N=2}^{M}\left\{1-\left(1-\frac{1}{c_1}\right)^{N-1}\right\}\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(2) Symbol Puncturing Probability

[Equation 2]

$$\sum_{N=2}^{M}\left[\sum_{i=0}^{s-1}\left\{1-\left(1-\frac{1-\pi_i}{c_1}\right)^{N-1}\right\}\cdot\pi_i\right]\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(3) Symbol Puncturing Probability when all π_i's are identical.

[Equation 3]

$$\sum_{N=2}^{M}\left\{1-\left(1-\frac{1-\frac{1}{s}}{c_1}\right)^{N-1}\right\}\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(3) Transmission Time (or Symbol Position) Hopping multiplexing

Assumption: c_2 = Total number of available symbol positions in multi-dimensional hopping patterns

(1) Collision Probability of Hopping Patterns

[Equation 4]

$$\sum_{N=2}^{M}\left\{1-\left(1-\frac{1}{c_2}\right)^{N-1}\right\}\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(2) Symbol Puncturing Probability

[Equation 5]

$$\sum_{N=2}^{M}\left[\sum_{i=0}^{t-1}\left\{1-\left(1-\frac{1-\pi_i}{c_2}\right)^{N-1}\right\}\cdot\pi_i\right]\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(3) Symbol Puncturing Probability when all π_i's are identical

[Equation 6]

$$\sum_{N=2}^{M}\left\{1-\left(1-\frac{1-\frac{1}{s}}{c_2}\right)^{N-1}\right\}\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(4) Orthogonal Code Hopping Multiplexing

Assumption: c_3 = Total number of orthogonal code symbols in multi-dimensional hopping patterns

(1) Collision Probability of Hopping Patterns

[Equation 7]

$$\sum_{N=2}^{M}\left\{1-\left(1-\frac{1}{c_3}\right)^{N-1}\right\}\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(2) Symbol Puncturing Probability

[Equation 8]

$$\sum_{N=2}^{M}\left[\sum_{i=0}^{s-1}\left\{1-\left(1-\frac{1-\pi_i}{c_3}\right)^{N-1}\right\}\cdot\pi_i\right]\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(4) Symbol Puncturing Probability when all π_i's are identical

[Equation 9]

$$\sum_{N=2}^{M}\left\{1-\left(1-\frac{1-\frac{1}{s}}{c_3}\right)^{N-1}\right\}\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(5) Frequency, Transmission Time, Orthogonal Code Hopping Multiplexing

Assumption:

c_1= Total number of sub-carriers of frequency axis in multi-dimensional hopping patterns

c_2= Total number of symbol positions of time axis in multi-dimensional hopping patterns

c_3= Total number of orthogonal code symbols of orthogonal code axis in multi-dimensional hopping patterns

(1) Collision Probability of Hopping Patterns

[Equation 10]

$$\sum_{N=2}^{M}\left\{1-\left(1-\frac{1}{c_1+c_2+c_3}\right)^{N-1}\right\}\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(1) Symbol Puncturing Probability

[Equation 11]

$$\sum_{N=2}^{M}\left[\sum_{i=0}^{\infty}\left\{1-\left(1-\frac{1-\pi_i}{c_1+c_2+c_3}\right)^{N-1}\right\}\cdot\pi_i\right]\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

(2) Symbol Puncturing Probability when all π_i's are identical

[Equation 12]

$$\sum_{N=2}^{M}\left\{1-\left(1-\frac{1-\frac{1}{s}}{c_1+c_2+c_3}\right)^{N-1}\right\}\binom{M-1}{N-1}\alpha^{N-1}(1-\alpha)^{M-N}$$

FIG. 15, like FIGs. 14g, 14o, 14r, 14u, and 14x illustrates an increase of transmission power of the primary communication station for a specific interval after the data symbols which are not transmitted in order to satisfy the required quality and to compensate for the average receiving energy required by the channel decoder when the transmission is halted in a collision interval of multi-dimensional hopping patterns.

The transmission stoppage due to the collision of multi-dimensional hopping patterns and the inconsistency of transmission data symbols occurs in a channel group that exists in the same transmission antenna beam toward the primary communication station. Whan a smart antenna like in FIG. 16 whose transmission antenna beam 1120, 1130, 1140 toward the primary communication station exists in plurality, even though the hopping patterns collide, the transmission for the channels 1132, 1142, 1144 in the transmission antenna beam 1130, 1140 in a collision interval is not stopped.

As can be seen from the embodiment of the present invention, when the multi-dimensional orthogonal resource hopping multiplexing is carried out by pseudo-random hopping patterns, a channel coding scheme in the transmission side and a channel decoding scheme in the

receiver's side are absolutely needed in order to recover the data that exist between a lost interval from the receiver's side because the transmission data can be punctured and not transmitted during the interval where the multi-dimensional hopping patterns collide.

The detailed explanation on the embodiments of the present invention has been focused on wireless mobile communication system. However, the statistical multiplexing proposed by the present invention can equally be implemented to wired communication systems.

As explained previously, the present invention, when the activity of synchronized channels that maintain orthogonalilty is low or the transmitting data rate for the channels varies below a basic transmission rate, can achieve statistical multiplexing gain on channels from the primary communication station to the secondary communication station, an increase in activity of the limited orthogonal resource, a decrease in signaling traffic due to unnecessary channel allocation and de-allocation (or release), a simple transmission scheduling, a decrease in buffer capacity required by the primary communication station, a decrease in transmission time delay, and a seamless handoff in adjacent cells by using a statistical multiplexing method known as multi-dimensional orthogonal resource multiplexing that takes frequency, time and orthogonal code as an orthogonal axis.

Further, the present invention can distinguish almost an infinite number of channels when multi-dimensional

resource patterns are selected pseudo randomly in comparison to the method which allocates the orthogonal resources fixedly. Also, in case of a collision that occurs due to a pseudo random selection of the hopping patterns, there is no need to stop the transmission of the colliding data symbols for the secondary communication stations which exist in an area where the transmission antenna beam is not overlapped like a sectorization or smart antenna.

The data symbols that are not transmitted due to collision of the hopping patterns between the channels in an identical transmission antenna beam, can be recovered through a channel decoding process of the secondary communication station without separately notifying the secondary communication station.

Also, using the present invention statistical multiplexing can be realized for all the orthogonal resources that include frequency, time, orthogonal code and polarization by implementing the method in the present invention.

WHAT IS CLAIMED IS:

1. A method for multi-dimensional orthogonal resource hopping multiplexing communication comprising a digital communication system that includes a primary communication station and secondary communication stations and a multi-dimensional orthogonal resource hopping multiplexing system for statistical multiplexing of the synchronous communication channels from said primary communication station to the secondary communication stations.

2. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 1,

wherein said multi-dimensional orthogonal resource hopping multiplexing system comprises;

a multi-dimensional hopping pattern generator which is located in the transmitter of the primary communication station,

a data symbol modulator that selects the corresponding orthogonal resource patterns in terms of the output from said multi-dimensional hopping pattern generator

a collision detector and controller that detects whether a collision occurs or not between the multi-dimensional hopping patterns and compares the consistency of the data symbols toward the secondary communication stations

between said collision interval,

a transmission power controller that controls the transmission power of the remaining parts except the part where the multi-dimensional hopping patterns collide and the transmission stops due to transmitting data symbol inconsistency, and compensates for the loss in the average reception energy due to a transmission stoppage.

3. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 1,

wherein said channels can be distinguished through hopping multi-dimensional orthogonal resource coordinates due to a synchronization from said primary communication station to a plurality of secondary communication stations.

4. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 3,

wherein said multi-dimensional orthogonal resource coordinates of dimension N can be represented as (orthogonal resource#1, orthogonal resource#2, ..., orthogonal resource#N)

5. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 4,

wherein said orthogonal resource#1 is frequency, the orthogonal resource#2 is transmission time or position of data symbol and orthogonal resource#3 is orthogonal code.

6. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said multi-dimensional orthogonal resource hopping is statistical multiplexing using a one-dimensional orthogonal resource hopping multiplexing method which only one coordinate of the orthogonal axes hops.

7. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 6,

wherein said one-dimensional orthogonal resource is frequency.

8. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 6,

wherein said one-dimensional orthogonal resource is transmission time or position of data symbol.

9. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 6,

wherein said one-dimensional orthogonal resource is orthogonal code.

10. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said multi-dimensional orthogonal resource hopping is statistical multiplexing using a two-dimensional orthogonal resource hopping multiplexing method in which two coordinates of the orthogonal axes hop.

11. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 10,

wherein said two-dimensional orthogonal resource consists of (frequency, transmission time or position).

12. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 10,

wherein said two-dimensional orthogonal resource consists of (frequency, orthogonal code).

13. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 10,

wherein said two-dimensional orthogonal resource

consists of (transmission time or position, orthogonal code).

14. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said multi-dimensional orthogonal resource hopping is statistical multiplexing using a three-dimensional orthogonal resource hopping multiplexing method in which three coordinates of the orthogonal axes undergo hopping.

15. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 14,

wherein said three-dimensional orthogonal resource consists of (frequency, transmission time or position, orthogonal code).

16. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said multi-dimensional orthogonal resource hopping of dimension N is statistical multiplexing using a multi-dimensional dimensional orthogonal resource hopping multiplexing method in which multi-dimensional (orthogonal resource#1, orthogonal resource#2, ..., orthogonal resource#N) coordinates of the orthogonal axes undergoes hopping.

17. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 5,

wherein said orthogonal code is Hadamard Code.

18. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 5,

wherein said orthogonal code is Orthogonal Variable Spreading Factor Code.

19. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 5,

wherein said orthogonal code is orthogonal Gold Code.

20. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 3,

wherein the multi-dimensional orthogonal resource hopping patterns between the secondary communication stations, which are allocated by said primary communication station to said secondary communication stations at the beginning of a communication and are released at the end of the communication, are dependent.

21. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 3,

wherein said multi-dimensional orthogonal resource hopping pattern is allocated to each secondary communication station uniquely and therefore, become independent between the secondary communication stations.

22. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said multi-dimensional orthogonal resource hopping multiplexing is carried out for statistically coarse or bursty channels in order to attain statistical multiplexing gain.

23. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 22,

wherein said bursty channels are communication channels toward the secondary communication stations whose transmission rate varies below the allocated basic transmission rate at the time of a call establishment.

24. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 22,

wherein said bursty channels are communication

channels toward the secondary communication stations whose transmission rate varies below the allocated average transmission rate at the time of a call establishment.

25. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein the physical channel control command toward a secondary communication station is transmitted by using a separate physical channel.

26. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 25,

wherein said physical channel includes the transmission power control command for the secondary communication station.

27. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 25,

wherein said physical channel includes the transmission rate of the primary communication station.

28. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 25,

wherein said physical channel contains the physical channel control command for the secondary communication station after time division multiplexed.

29. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 28,

wherein said physical channel does not collide with other orthogonal transmission channels from the primary communication station.

30. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 29,

wherein multi-dimensional hopping patterns which do not collide, are used in order not to collide said physical channel with other orthogonal transmission channels from the primary communication station.

31. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 29,

wherein fixed orthogonal resource allocation like the conventional orthogonal resource division multiplexing method is included so that said physical channel does not collide with other orthogonal transmission channels from the primary communication station.

32. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said multi-dimensional orthogonal resource hopping patterns for a statistical multiplexing are pseudo-randomly generated.

33. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 32,

wherein said pseudo-randomly generated multi-dimensional orthogonal resource hopping patterns are generated by Pseudo Noise (PN) sequence generators.

34. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 32,

wherein a plurality of said multi-dimensional orthogonal resource hopping patterns for statistical multiplexing can be allocated to one of the secondary communication stations according to the transmission data rate of the primary communication station.

35. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 34,

wherein a plurality of hopping patterns toward one of the secondary communication stations undergo dependent hopping in a communication by said multi-dimensional orthogonal resource hopping patterns in order to avoid collisions.

36. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 34,

wherein said communication by said multi-dimensional orthogonal resource hopping patterns allows collisions by undergoing independent hopping

37. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said communication by said multi-dimensional orthogonal resource hopping patterns periodically repeat on the basis of a frame unit.

38. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 37,

wherein said frame is an independent data unit based on the channel coding.

39. The method for multi-dimensional orthogonal

resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein the collisions of multi-dimensional orthogonal resource hopping patterns occurring from independent multi-dimensional orthogonal resource hopping patterns of said channels toward the secondary communication stations can cause not to transmit the data symbols of all corresponding channels during the symbol duration by previously detecting collisions at the primary communication station.

40. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said data symbols are transmitted when a comparison at the time of a collision of said multi-dimensional orthogonal resource hopping patterns shows that all the transmitting data symbols of corresponding channels are identical.

41. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said data symbols are not transmitted when a comparison at the time of a collision of said multi-dimensional orthogonal resource hopping patterns shows that not all the transmitting data symbols of corresponding channels are identical.

42. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 41,

wherein the transmission power is increased for the transmitting data symbols after the transmitting data symbols are not transmitted because the transmitting data symbols are not identical at the time of a collision of said multi-dimensional orthogonal resource hopping patterns.

43. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 42,

wherein said transmission power increase is allowed in such an amount and at an interval given by the system parameters.

44. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 43,

wherein said two system parameters depend on the location of the data symbols which are not transmitted.

45. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 44,

wherein said two system parameters are equal to or

greater than zero.

46. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 3,

wherein said hopping pattern collision processing method is only carried out when a serious error occurs during a channel decoding process in the secondary communication stations due to an overlapping of transmission antenna beams of the channels from the primary communication station where the hopping patterns collide.

47. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in one of claims 1 to 4,

wherein said multi-dimensional hopping pattern collision processing method is only carried out when a serious error occurs during a channel decoding process in the secondary communication stations due to an overlapping of transmission antenna beams of the channels in the primary communication station where the multi-dimensional hopping patterns collide.

48. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 1,

wherein a pilot signal is used for coherent demodulation

through acquisition, tracking and phase estimation.

49. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 48,

wherein said multi-dimensional hopping patterns use the hopping patterns which do not collide in order to protect from a loss of phase distortion compensation capability due to collisions.

50. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 48,

wherein said pilot signal exists in all sub-carriers that are involved in frequency hopping multiplexing.

51. The method for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 49,

wherein said hopping patterns which do not collide include an allocation of fixed orthogonal resource like the multi-dimensional orthogonal resource division multiplexing method.

52. An apparatus for multi-dimensional orthogonal resource hopping multiplexing communication comprising;

a multi-dimensional orthogonal resource hopping pattern generator

a multi-dimensional orthogonal resource generator that generates multi-dimensional orthogonal resource according to said multi-dimensional hopping patterns

a multi-dimensional hopping pattern collision detector that detects the collision of said multi-dimensional hopping patterns.

53. The apparatus for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 52,

wherein said multi-dimensional orthogonal resource generator consists of a frequency synthesizer.

54. The apparatus for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 52,

wherein said multi-dimensional orthogonal resource generator consists of buffers for controlling the position of transmission data symbol.

55. The apparatus for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 52,

wherein said multi-dimensional orthogonal resource generator consists of an orthogonal code generator.

56. The apparatus for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 52,

wherein said multi-dimensional orthogonal resource generator consists of a combination of a frequency synthesizer, buffers, a spreading orthogonal code generator.

57. The apparatus for multi-dimensional orthogonal resource hopping multiplexing communication as claimed in claim 52,

wherein said multi-dimensional hopping pattern collision detector comprising;

a transmitting data symbol comparator which compares whether the data symbols for the corresponding channels are identical or not at the time of collision of said multi-dimensional hopping patterns,

a puncturer which can stop the transmission of the data symbol when said comparator indicates that all the corresponding data symbols are not identical.

58. An apparatus for multi-dimensional orthogonal resource hopping multiplexing communication of a spread spectrum communication comprising a digital communication system that includes a transmission apparatus of the primary communication station and a reception apparatus of the secondary communication station,

wherein said transmission apparatus of the primary communication station comprising;

a channel encoder

a multi-dimensional orthogonal resource hopping pattern generator

a multi-dimensional orthogonal resource generator that generates multi-dimensional orthogonal resources according to said multi-dimensional hopping pattern.

59. An apparatus for multi-dimensional orthogonal resource hopping multiplexing communication of a spread spectrum communication comprising a digital communication system for multi-dimensional orthogonal resource hopping multiplexing which operates with two separate orthogonal resource groups comprising;

a first orthogonal resource group for a division multiplexing by fixed and exclusive allocation of orthogonal resources

a second orthogonal resource group for a statistical multiplexing through orthogonal resource hopping.

60. An apparatus for multi-dimensional orthogonal resource hopping multiplexing communication of a spread spectrum communication as claimed in claim 59,

wherein a multi-dimensional orthogonal resource division multiplexing is carried out for a less bursty channels by fixedly and exclusively allocating the orthogonal resources

in said first orthogonal resource group to the transmitting data symbols.

61. An apparatus for multi-dimensional orthogonal resource hopping multiplexing communication of a spread spectrum communication as claimed in claim 59,

wherein a multi-dimensional orthogonal resource hopping multiplexing is carried out using multi-dimensional orthogonal resource hopping patterns for a bursty channels by using the orthogonal resources in said second orthogonal resource group.

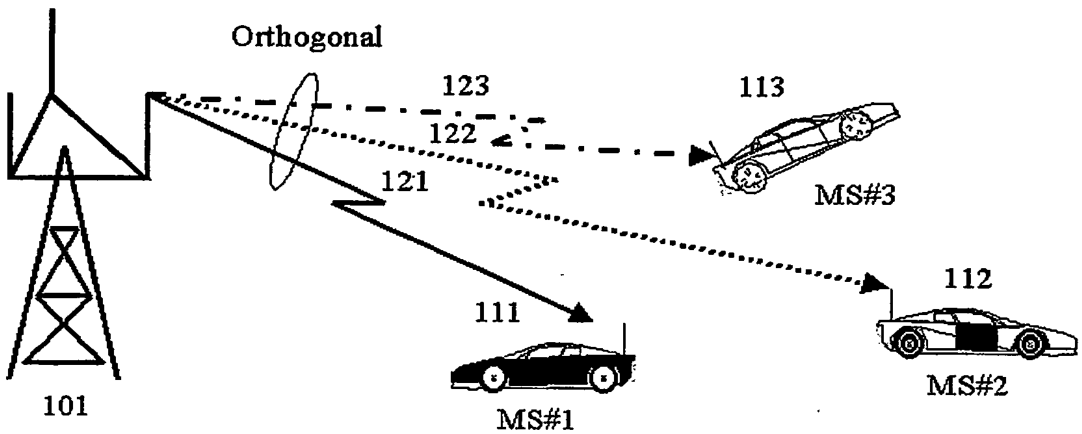


FIG. 1

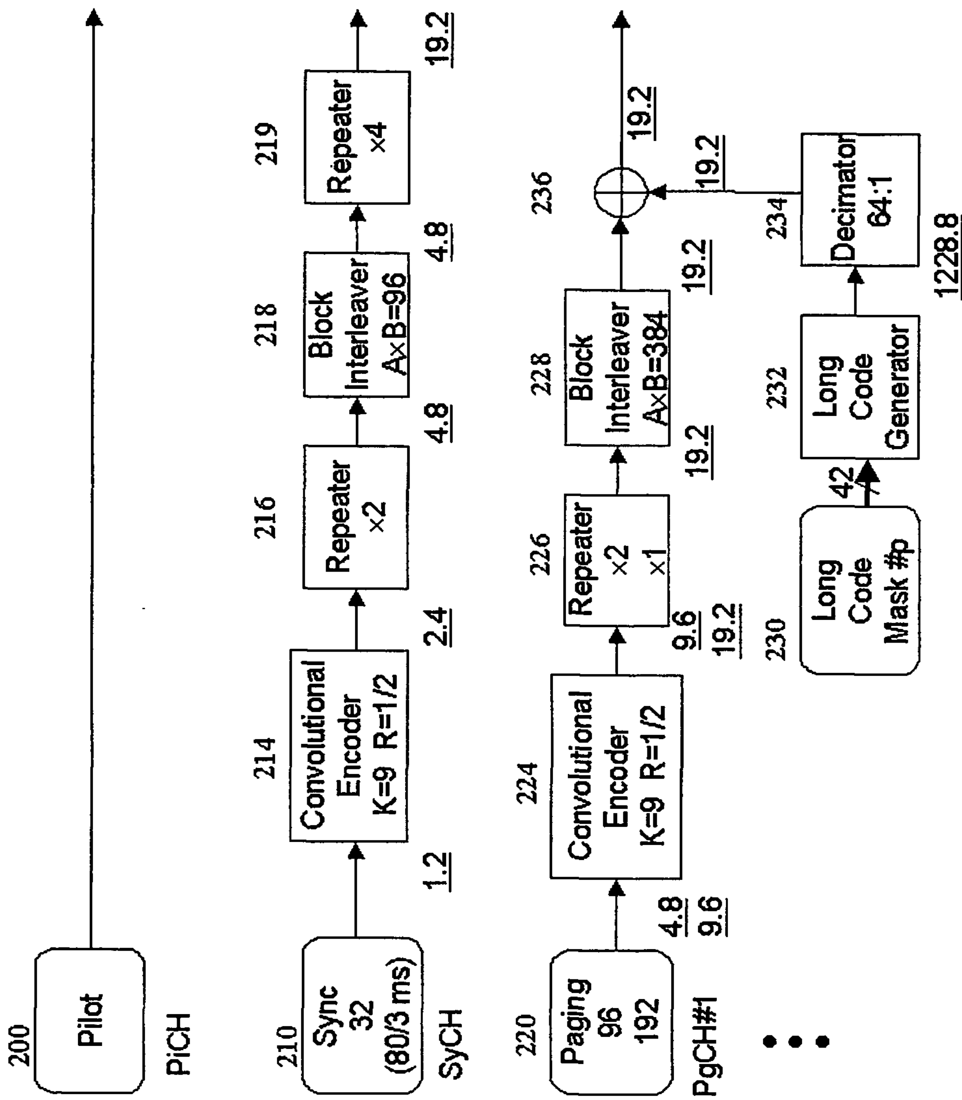

200
Pilot
PiCH
210
Sync
32
(80/3 ms)
SyCH
214
Convolutional Encoder K=9 R=1/2
216
Repeater ×2
218
Block Interleaver A×B=96
219
Repeater ×4
1.2
2.4
4.8
4.8
19.2
220
Paging
96
192
PgCH#1
224
Convolutional Encoder K=9 R=1/2
226
Repeater ×2 ×1
228
Block Interleaver A×B=384
236
4.8
9.6
9.6
19.2
19.2
19.2
19.2
19.2
230
Long Code Mask #p
42
232
Long Code Generator
234
Decimator 64:1
1228.8

FIG. 2a

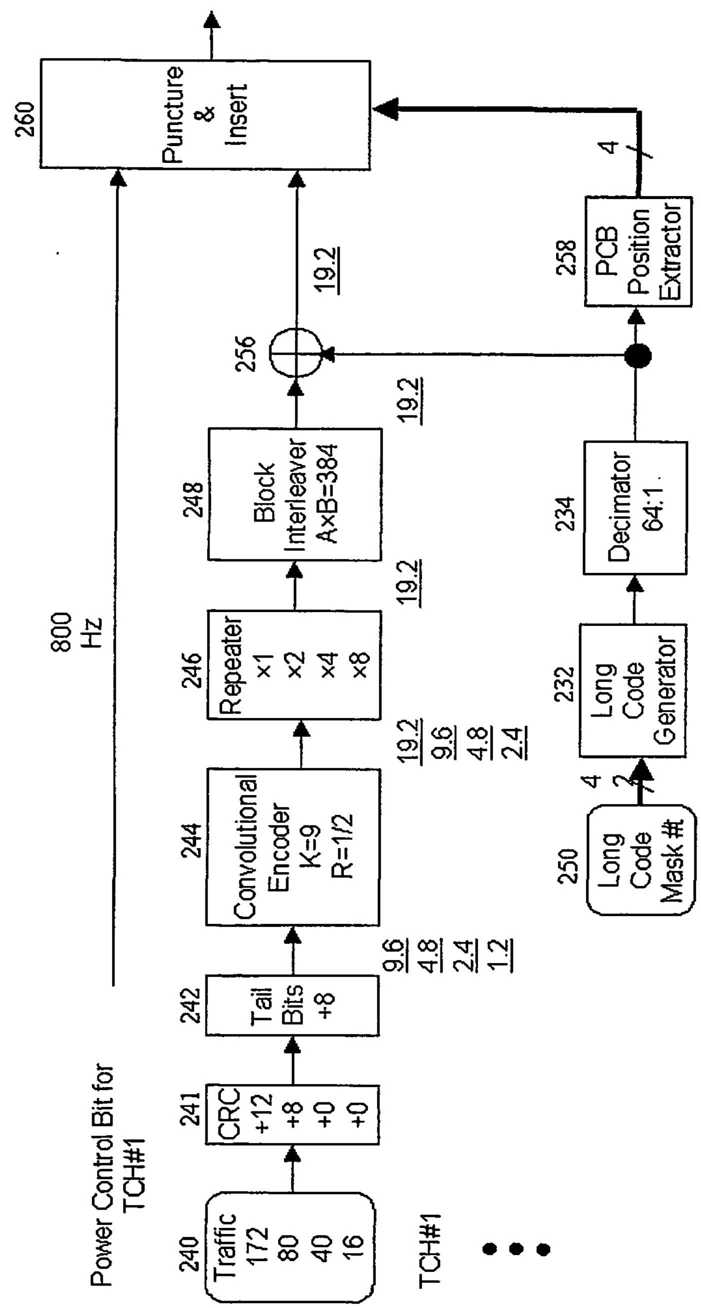

260
Puncture
&
Insert
4
258
PCB
Position
Extractor
19.2
256
800
Hz
248
Block
Interleaver
A×B=384
19.2
234
Decimator
64:1
19.2
1228.8
246
Repeater
×1
×2
×4
×8
19.2
232
Long
Code
Generator
244
Convolutional
Encoder
K=9
R=1/2
19.2
9.6
4.8
2.4
4
2
250
Long
Code
Mask #
242
Tail
Bits
+8
9.6
4.8
2.4
1.2
241
CRC
+12
+8
+0
+0
Power Control Bit for
TCH#1
240
Traffic
172
80
40
16
TCH#1

FIG. 2b

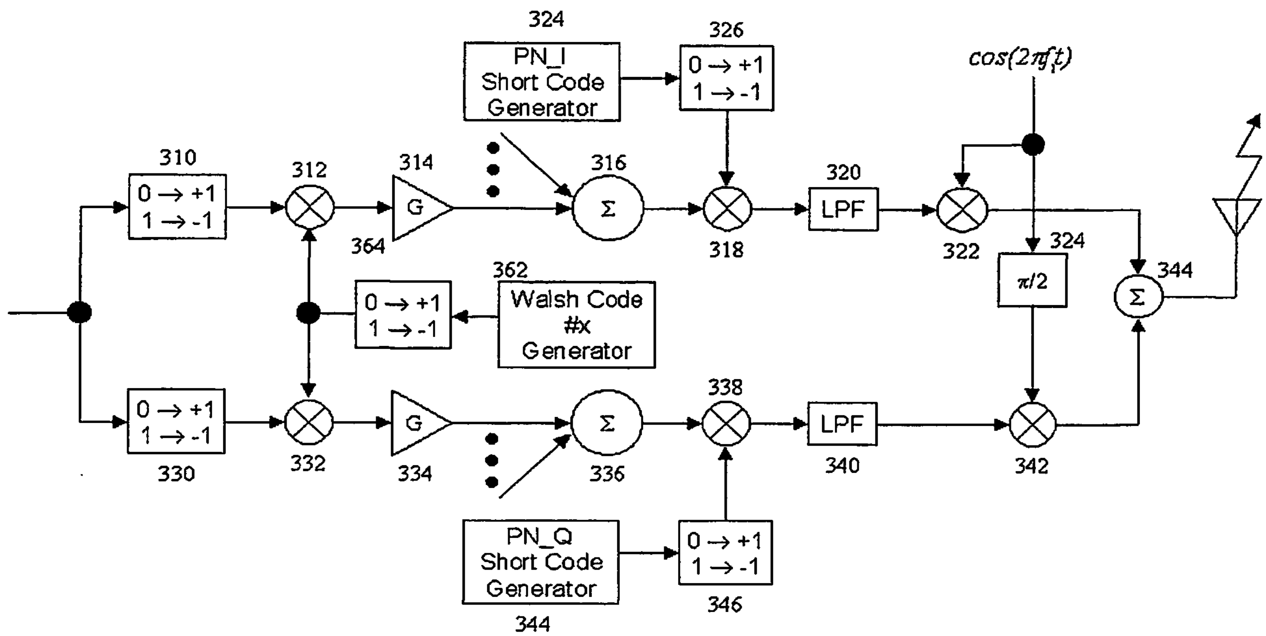

324
PN_I
Short Code
Generator
326
0 → +1
1 → -1
cos(2πf_it)
310
0 → +1
1 → -1
312
314
G
316
Σ
320
LPF
318
322
364
324
π/2
344
Σ
362
0 → +1
1 → -1
Walsh Code
#x
Generator
338
0 → +1
1 → -1
G
Σ
LPF
330
332
334
336
340
342
PN_Q
Short Code
Generator
0 → +1
1 → -1
346
344

FIG. 3a

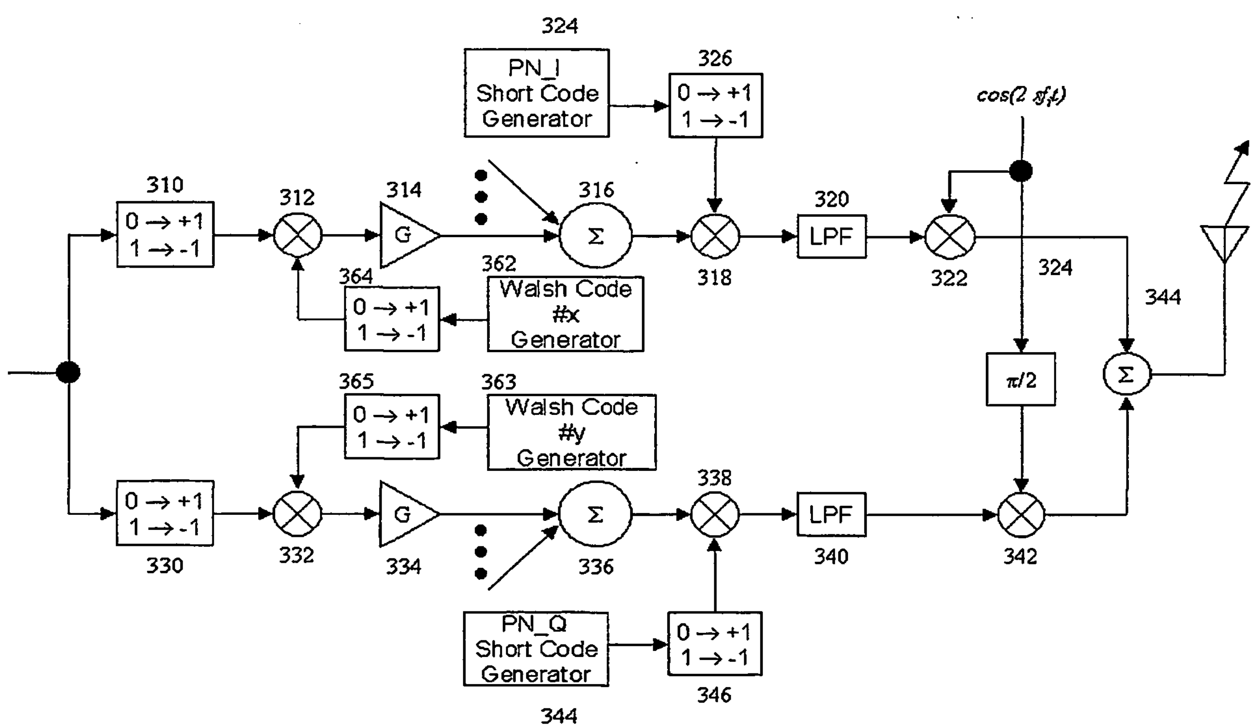

324
PN_I
Short Code
Generator
326
0 → +1
1 → -1
cos(2 πf_it)
310
0 → +1
1 → -1
312
314
G
316
Σ
320
LPF
318
322
364
362
0 → +1
1 → -1
Walsh Code
#x
Generator
324
344
π/2
Σ
365
363
0 → +1
1 → -1
Walsh Code
#y
Generator
338
0 → +1
1 → -1
G
Σ
LPF
330
332
334
336
340
342
PN_Q
Short Code
Generator
0 → +1
1 → -1
346
344

FIG. 3b

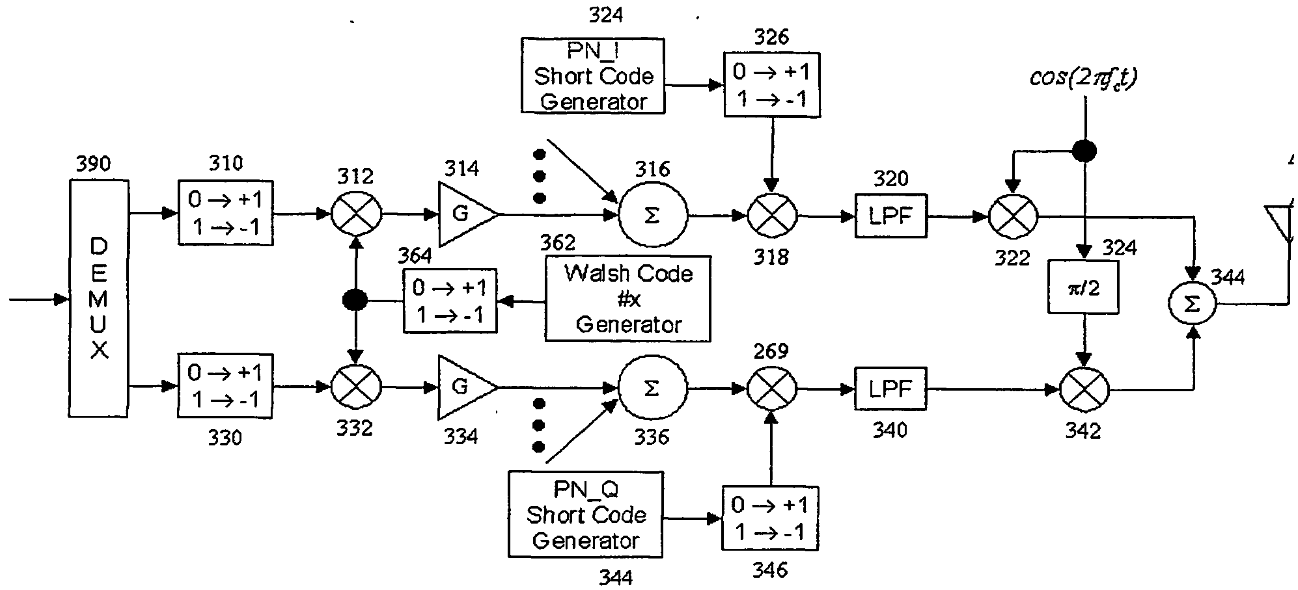

324
PN_I
Short Code
Generator
326
0 → +1
1 → -1
cos(2πf_ct)
390
DEMUX
310
0 → +1
1 → -1
312
314
G
316
Σ
318
320
LPF
322
324
π/2
344
Σ
362
Walsh Code
#x
Generator
364
0 → +1
1 → -1
330
0 → +1
1 → -1
332
334
G
336
Σ
269
340
LPF
342
PN_Q
Short Code
Generator
344
0 → +1
1 → -1
346

FIG. 3c

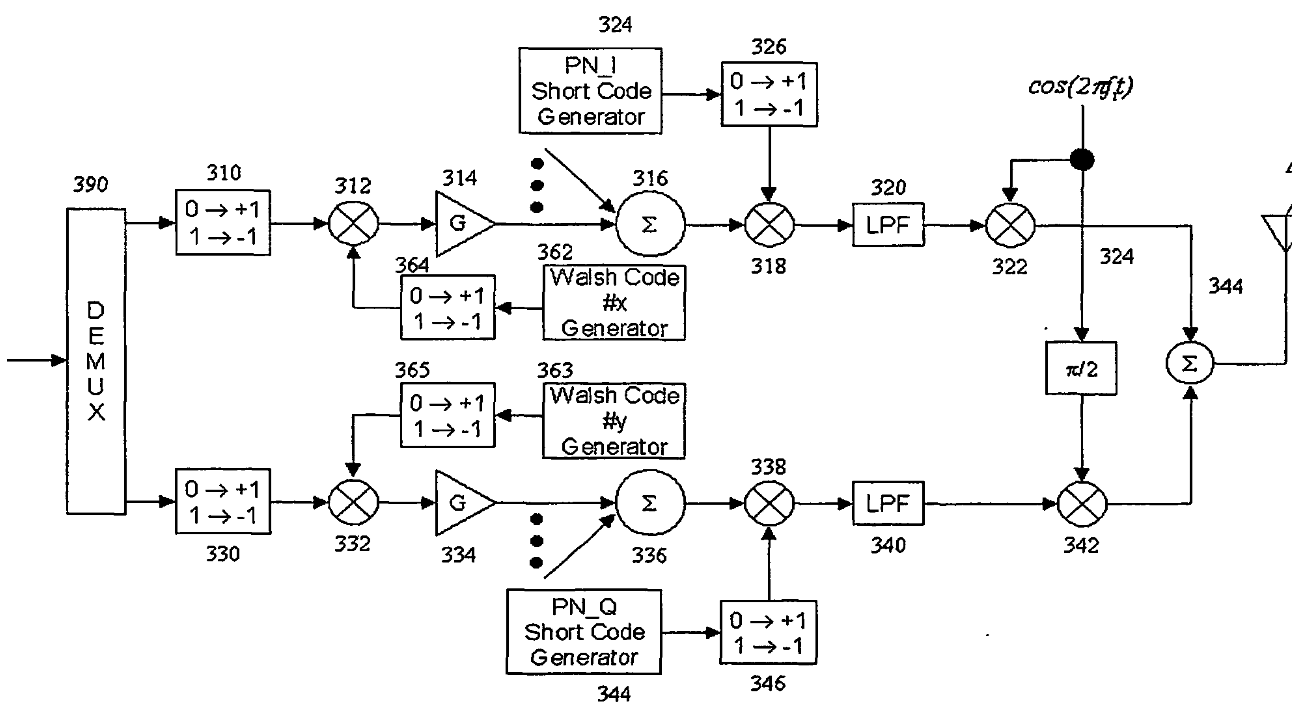

324
PN_I
Short Code
Generator
326
0 → +1
1 → -1
cos(2πf_ct)
390
DEMUX
310
0 → +1
1 → -1
312
314
G
316
Σ
318
320
LPF
322
324
344
π/2
Σ
364
0 → +1
1 → -1
362
Walsh Code
#x
Generator
365
0 → +1
1 → -1
363
Walsh Code
#y
Generator
330
0 → +1
1 → -1
332
334
G
336
Σ
338
340
LPF
342
PN_Q
Short Code
Generator
344
0 → +1
1 → -1
346

FIG. 3d

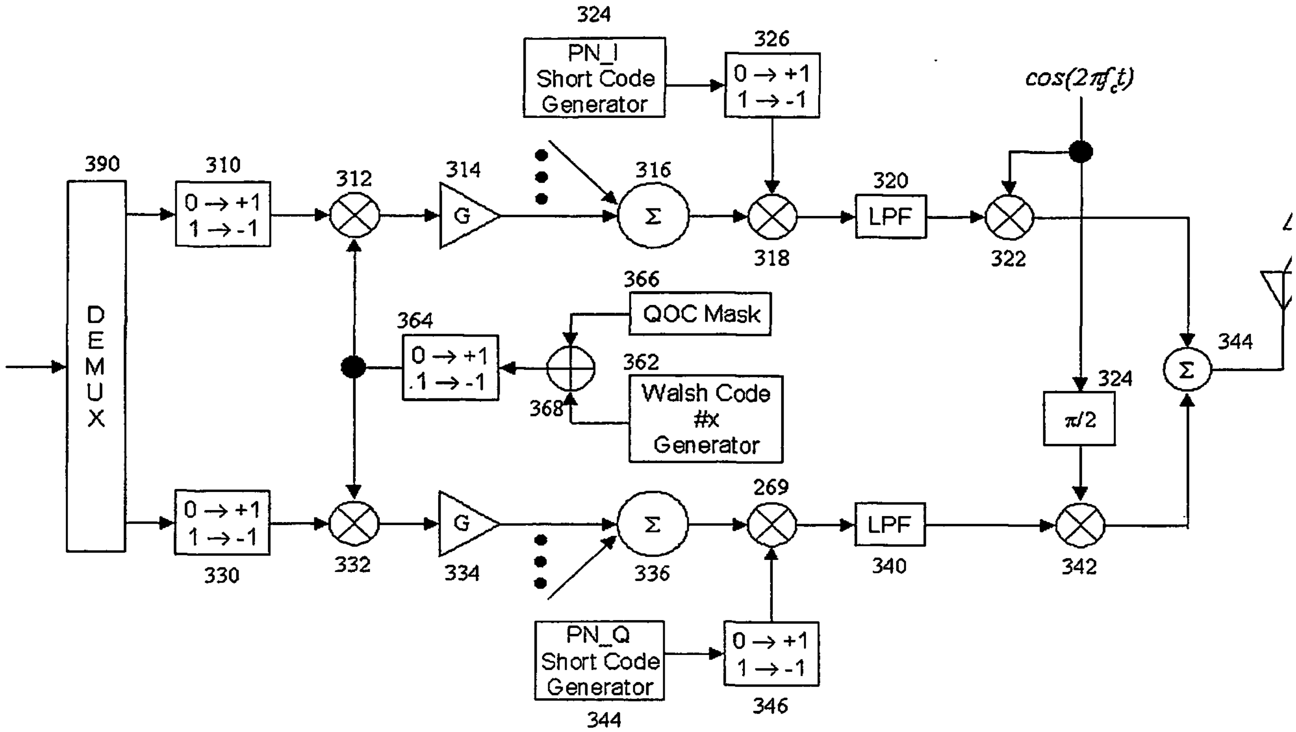

324
PN_I Short Code Generator
326
0 → +1
1 → -1
cos(2πf_ct)
390
310
312
314
316
320
LPF
318
322
DEMUX
G
366
QOC Mask
364
362
Walsh Code #x Generator
368
344
324
π/2
269
330
332
334
336
340
342
PN_Q Short Code Generator
344
346

FIG. 3e

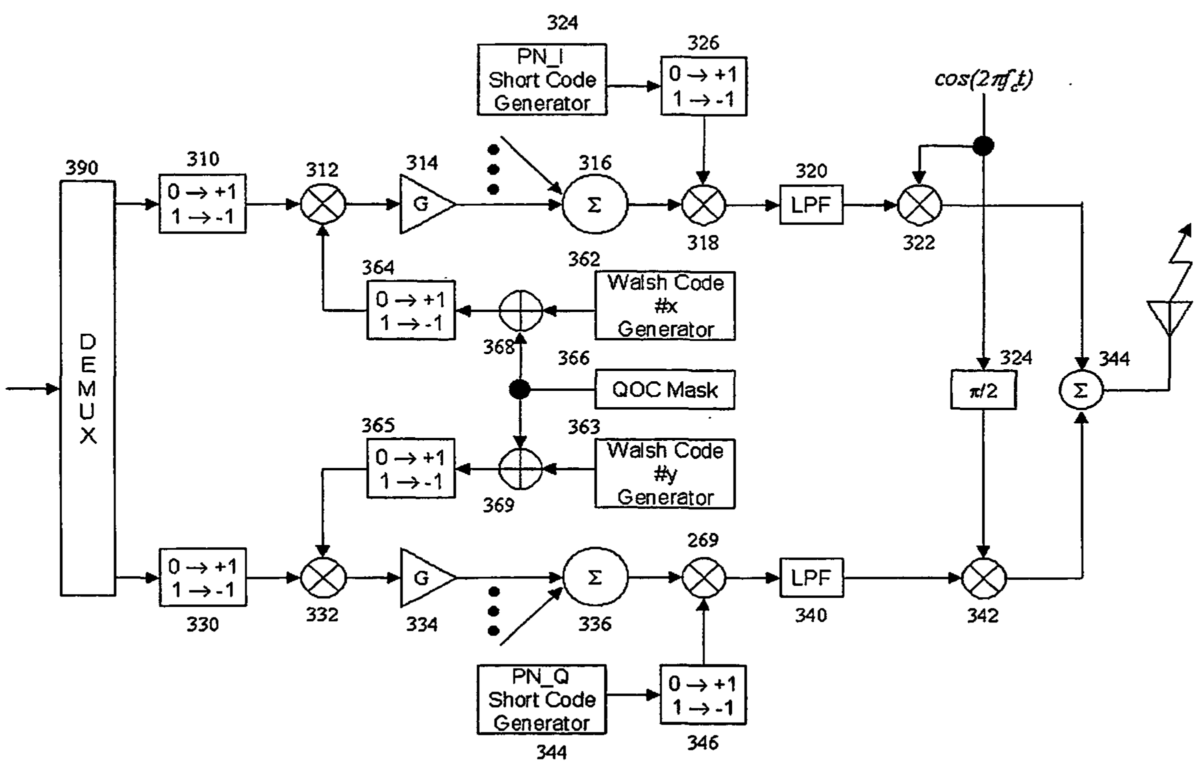

324
PN_I Short Code Generator
326
0 → +1
1 → -1
cos(2πf_ct)
390
310
312
314
316
320
LPF
318
322
DEMUX
G
364
362
Walsh Code #x Generator
368
366
QOC Mask
365
363
Walsh Code #y Generator
369
324
π/2
344
269
330
332
334
336
340
342
PN_Q Short Code Generator
344
346

FIG. 3f

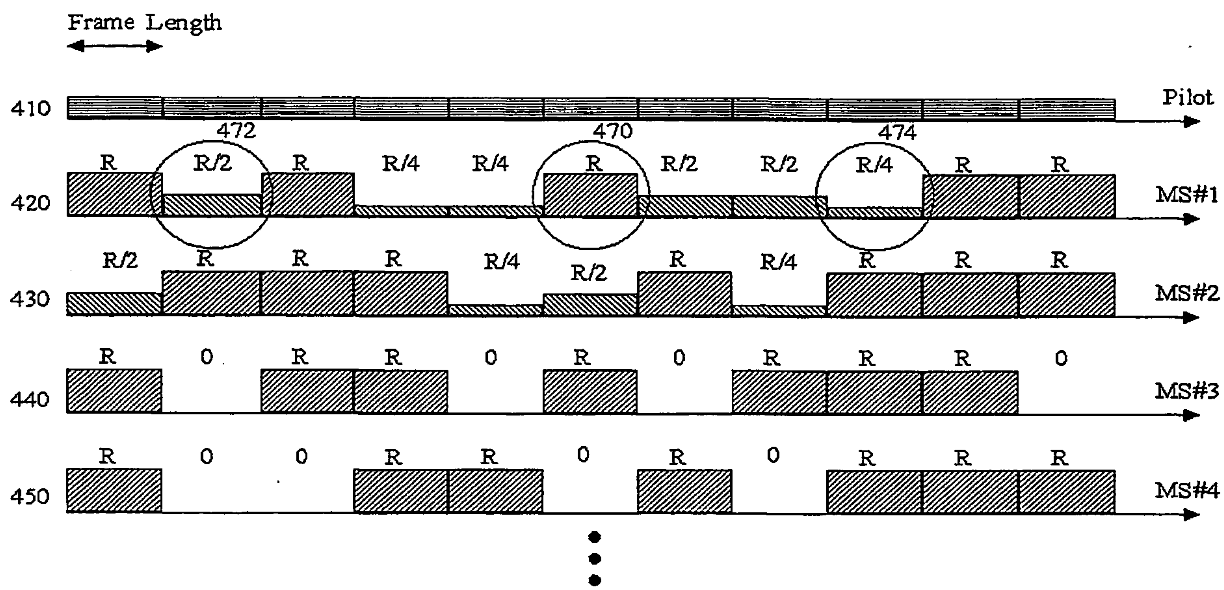

Frame Length
410
Pilot
472
470
474
R
R/2
R
R/4
R/4
R
R/2
R/2
R/4
R
R
420
MS#1
R/2
R
R
R
R/4
R/2
R
R/4
R
R
R
430
MS#2
R
0
R
R
0
R
0
R
R
R
0
440
MS#3
R
0
0
R
R
0
R
0
R
R
R
450
MS#4

FIG 4a

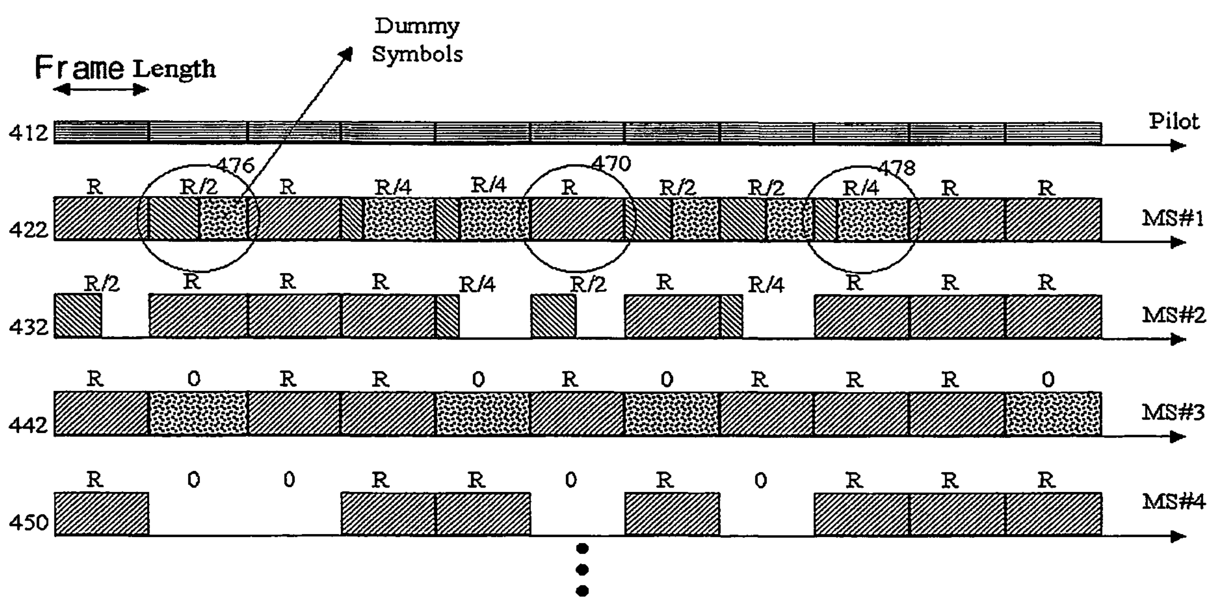

Dummy Symbols
Frame Length
412
Pilot
476
470
478
R
R/2
R
R/4
R/4
R
R/2
R/2
R/4
R
R
422
MS#1
R/2
R
R
R
R/4
R/2
R
R/4
R
R
R
432
MS#2
R
0
R
R
0
R
0
R
R
R
0
442
MS#3
R
0
0
R
R
0
R
0
R
R
R
450
MS#4

FIG. 4b

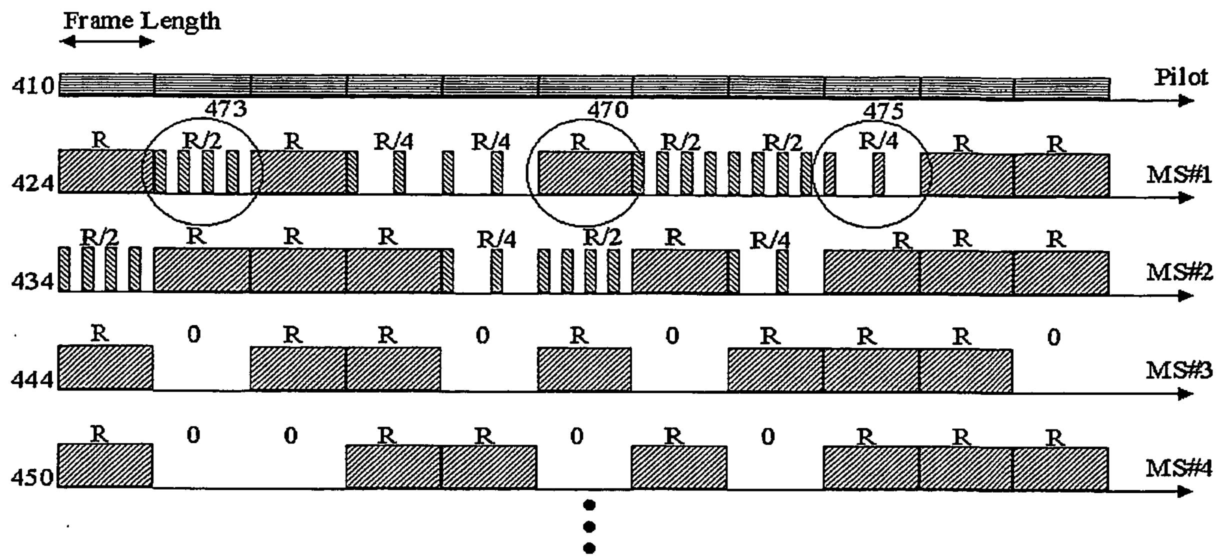

Frame Length
410
Pilot
473
470
475
424
MS#1
434
MS#2
444
MS#3
450
MS#4

FIG. 4c

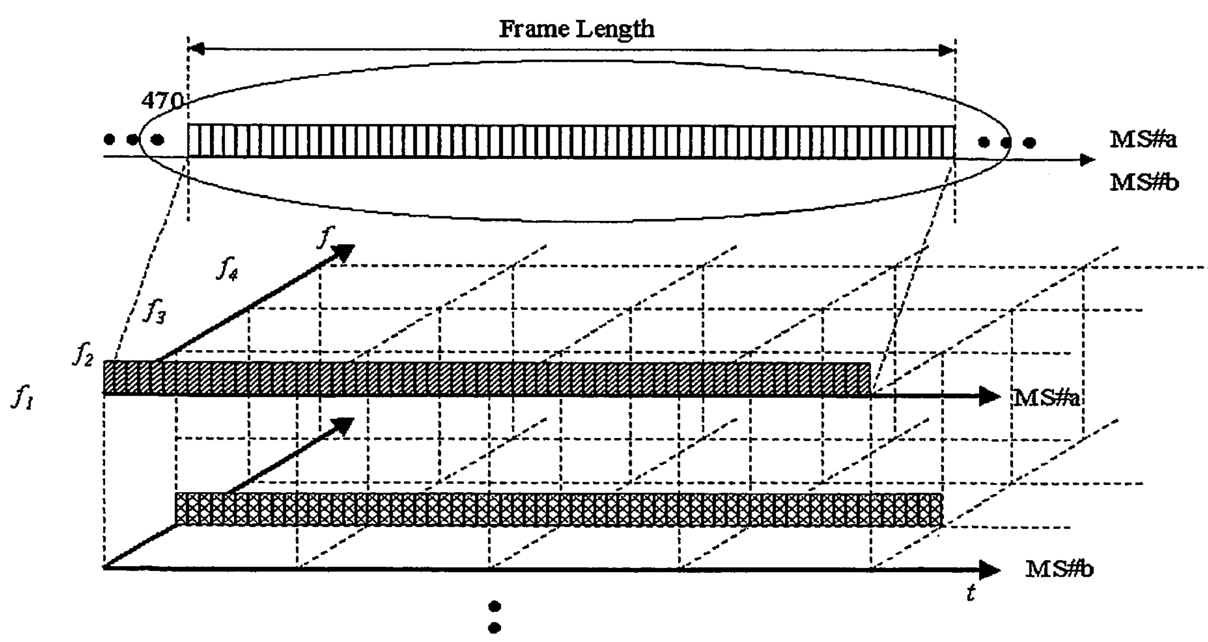

Frame Length
470
MS#a
MS#b
f
f4
f3
f2
f1
MS#a
MS#b
t

FIG. 4d

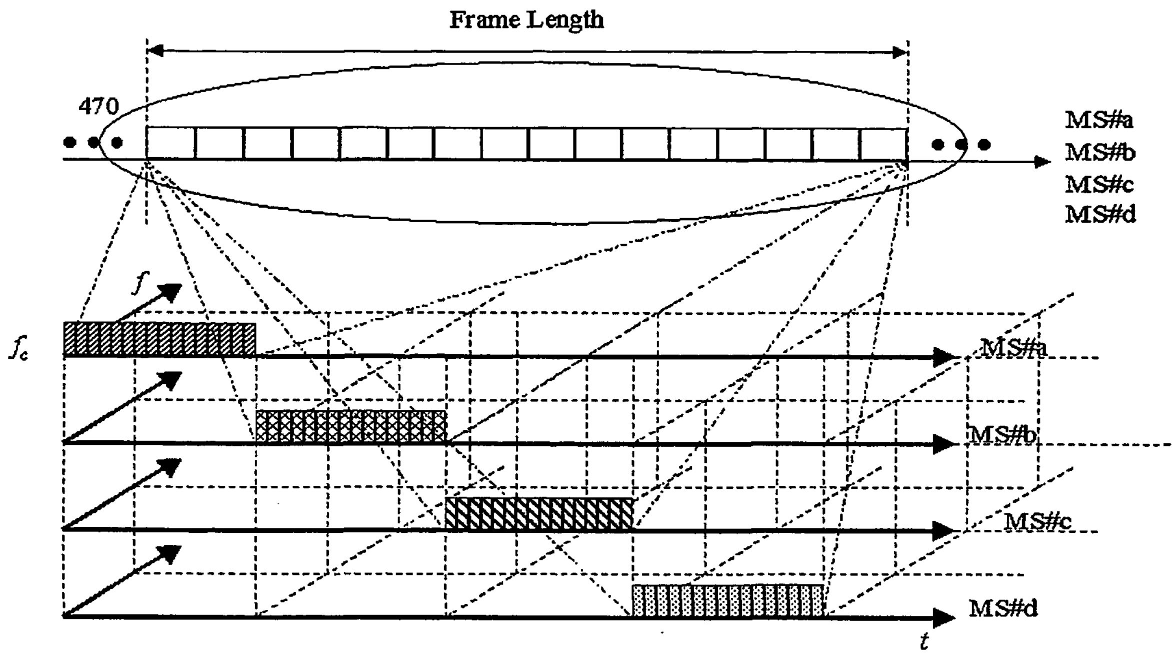

Frame Length
470
MS#a
MS#b
MS#c
MS#d
f
f_c
MS#a
MS#b
MS#c
MS#d
t

FIG. 4e

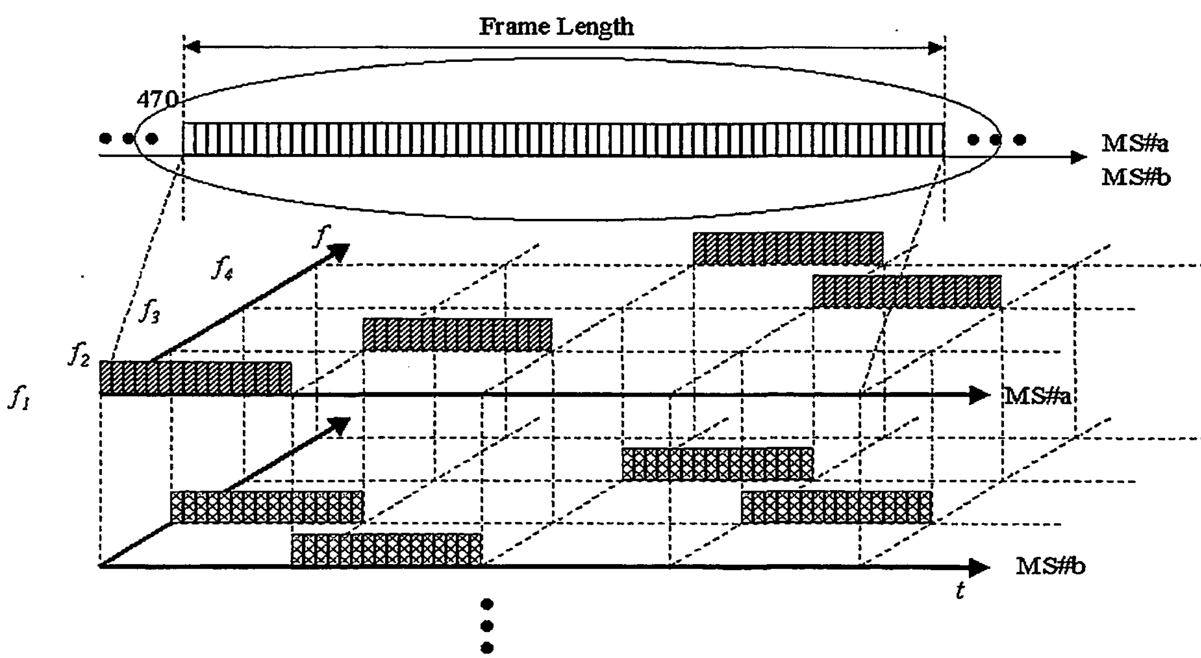

Frame Length
470
MS#a
MS#b
f
f_4
f_3
f_2
f_1
MS#a
MS#b
t

FIG. 4f

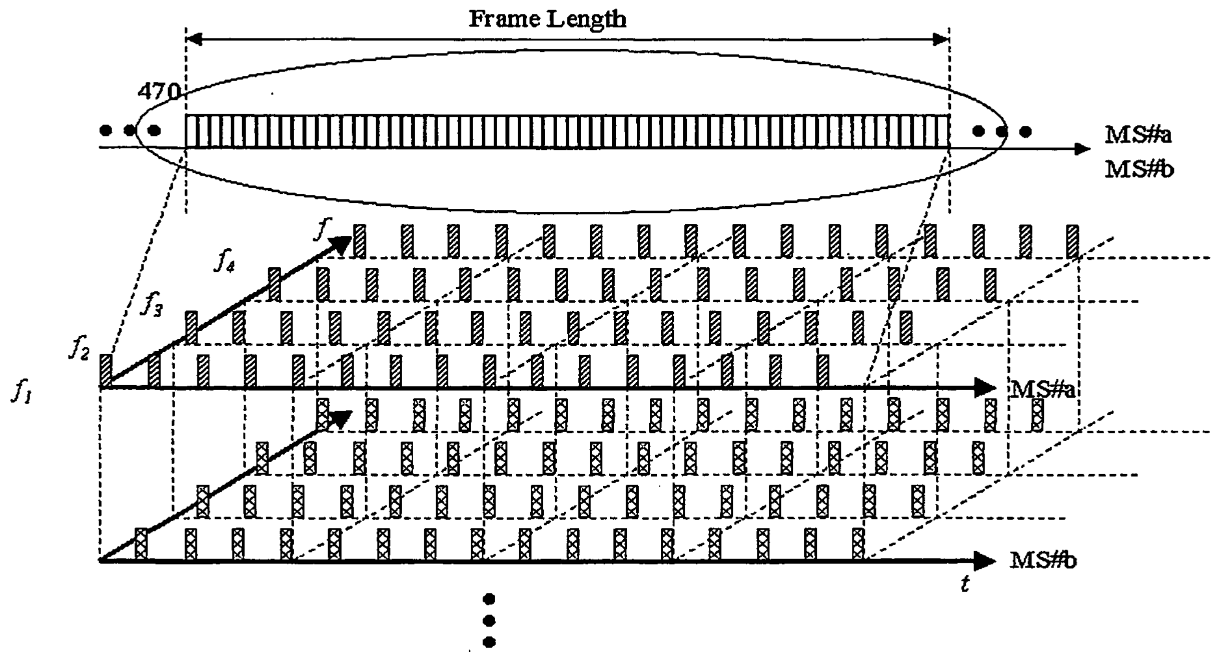

Frame Length
470
MS#a
MS#b
f
f4
f3
f2
f1
MS#a
MS#b
t

FIG. 4g

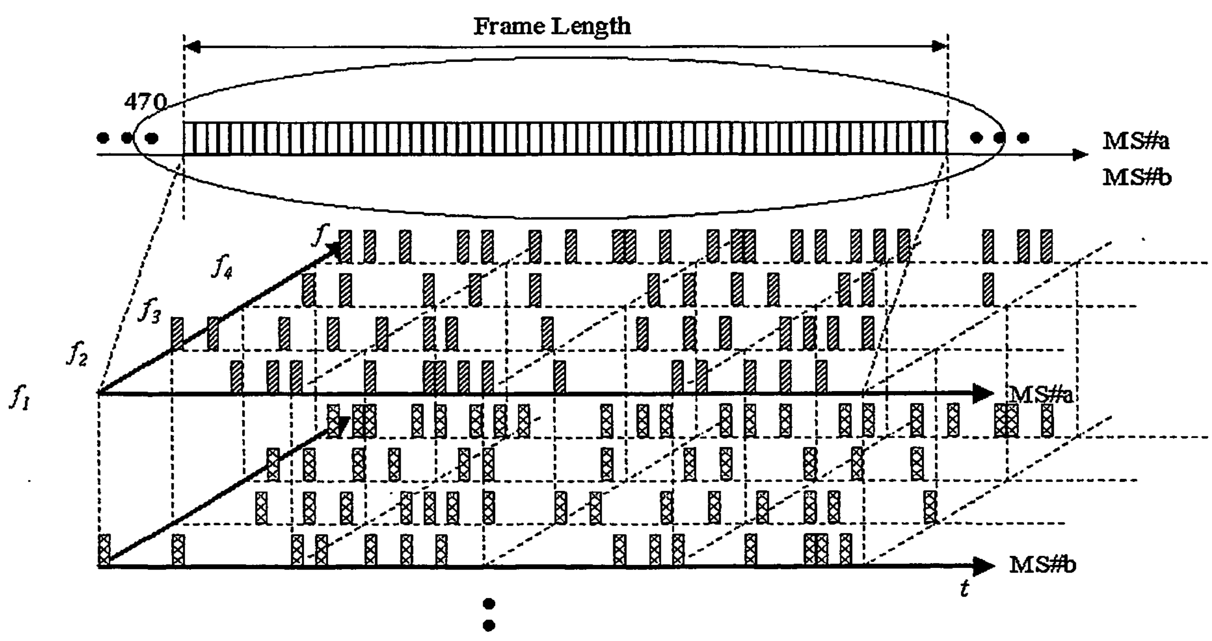

Frame Length
470
MS#a
MS#b
f
f4
f3
f2
f1
MS#a
MS#b
t

FIG. 4h

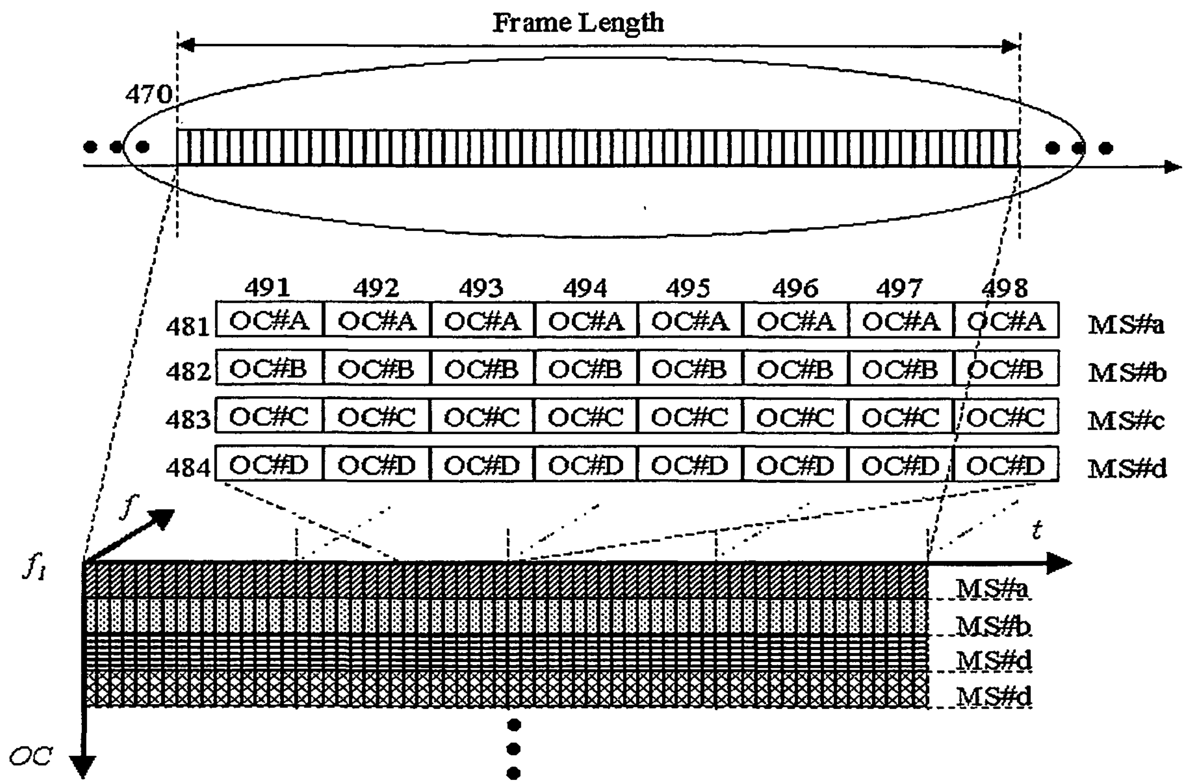

Frame Length
470
491
492
493
494
495
496
497
498
481
482
483
484
OC#A
OC#B
OC#C
OC#D
MS#a
MS#b
MS#c
MS#d
f
f1
t
OC
MS#a
MS#b
MS#d
MS#d

FIG. 4i

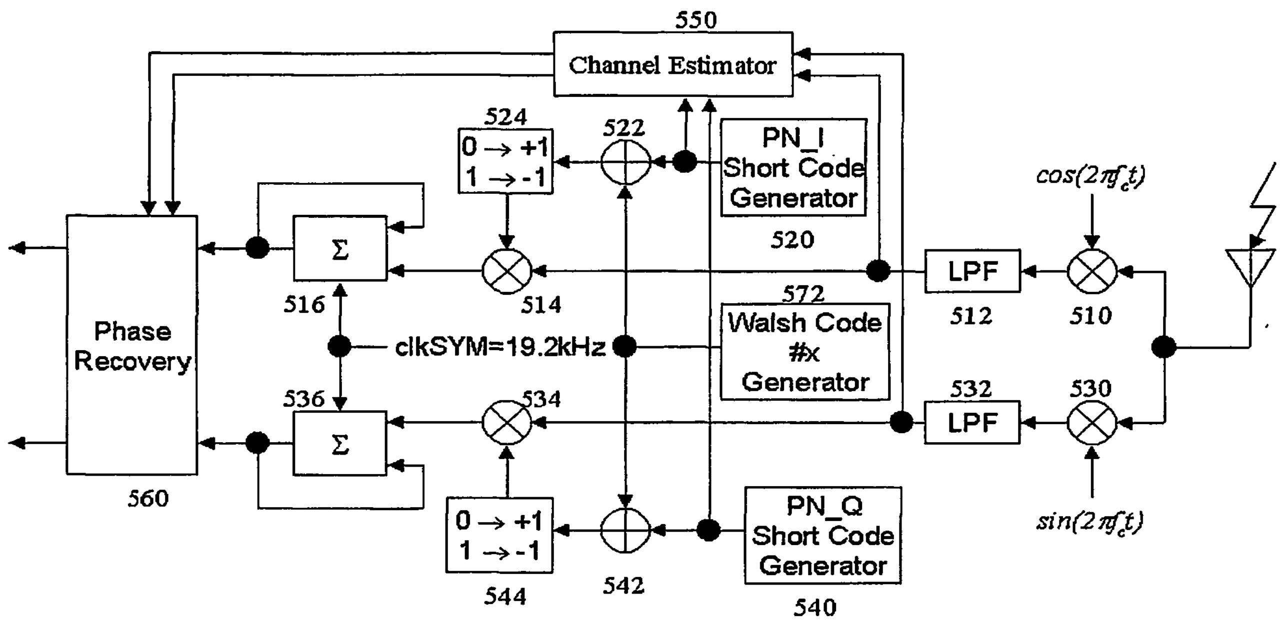

550
Channel Estimator
524
0 → +1
1 → -1
522
PN_I
Short Code
Generator
520
cos(2πf_ct)
Phase
Recovery
Σ
516
514
LPF
512
510
572
Walsh Code
#x
Generator
clkSYM=19.2kHz
536
534
Σ
532
LPF
530
560
0 → +1
1 → -1
544
542
PN_Q
Short Code
Generator
540
sin(2πf_ct)

FIG. 5

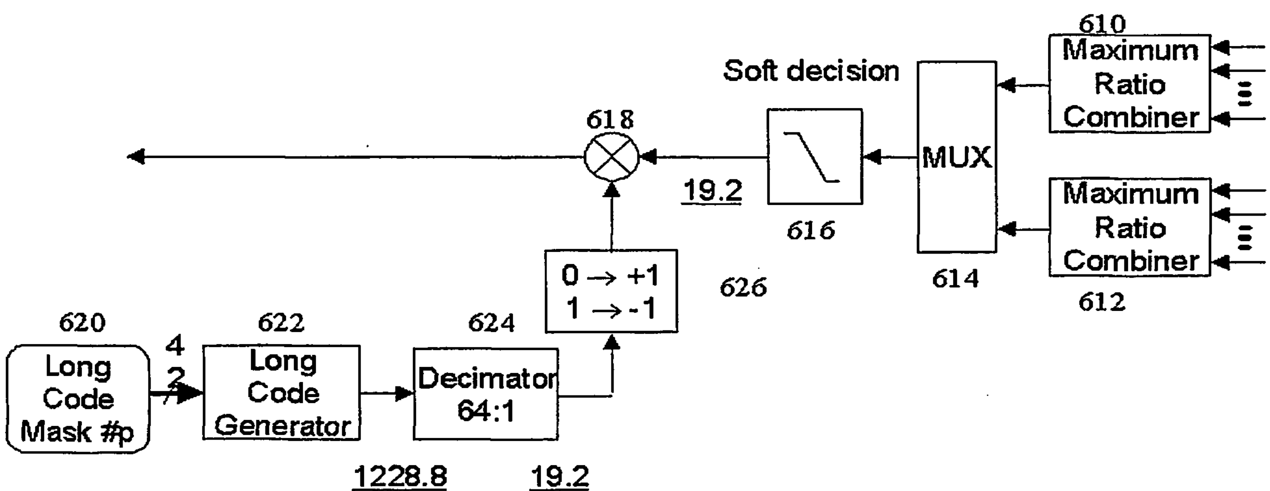

610
Maximum
Ratio
Combiner
Soft decision
MUX
618
19.2
616
614
Maximum
Ratio
Combiner
612
0 → +1
1 → -1
626
620
Long
Code
Mask #p
4
2
622
Long
Code
Generator
624
Decimator
64:1
1228.8
19.2

FIG. 6

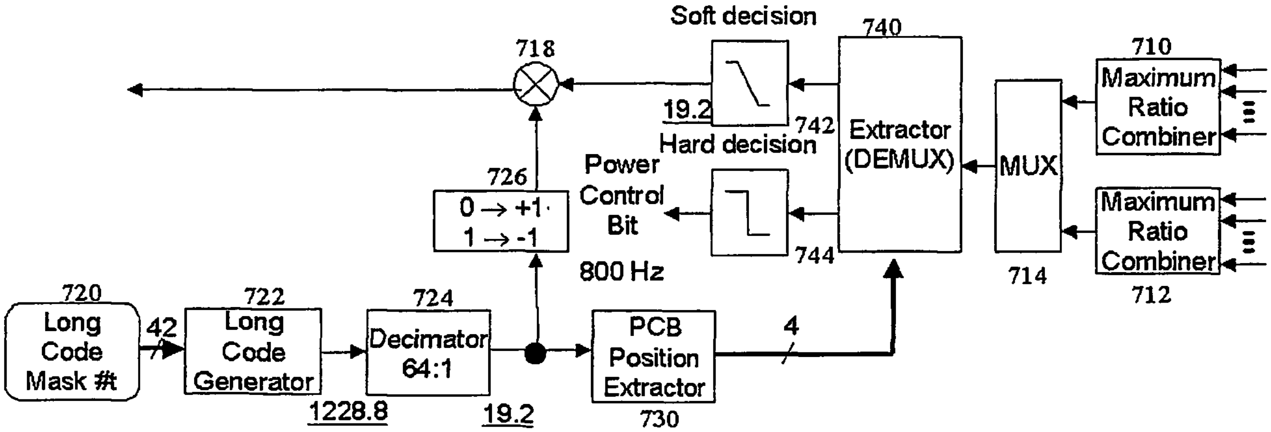

Soft decision
740
710
718
Maximum Ratio Combiner
19.2
742
Hard decision
Extractor (DEMUX)
MUX
Power Control Bit
726
0 → +1
1 → -1
Maximum Ratio Combiner
744
800 Hz
714
712
720
Long Code Mask #
42
722
Long Code Generator
724
Decimator 64:1
PCB Position Extractor
4
1228.8
19.2
730

FIG. 7

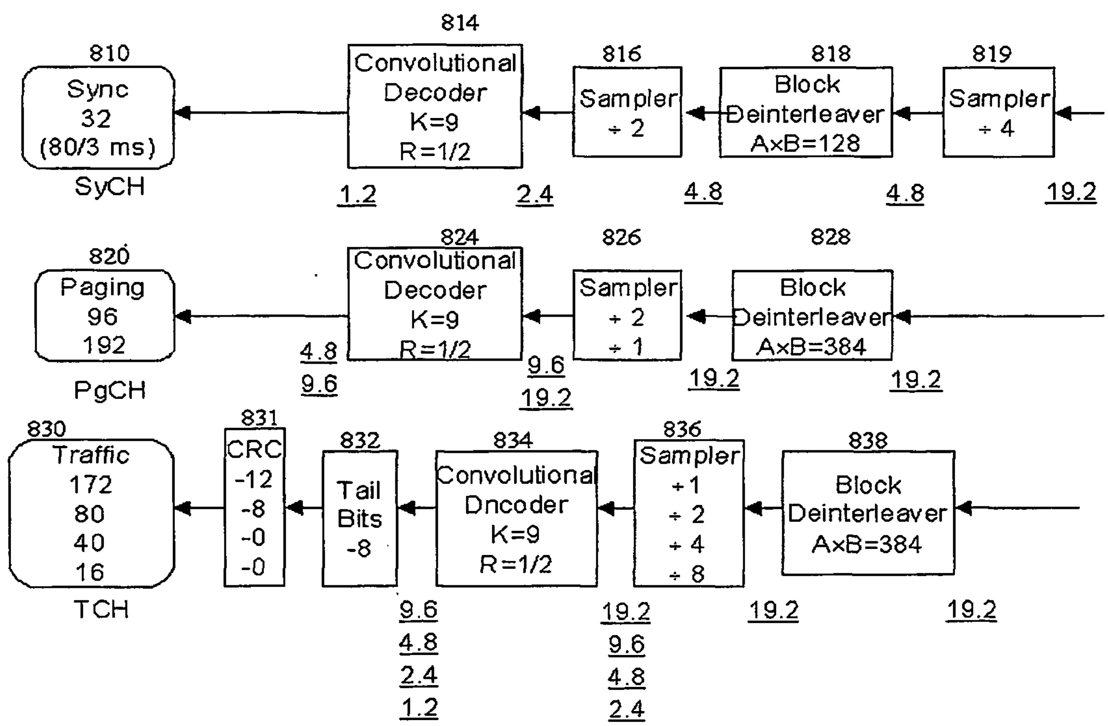

814
810
Sync
32
(80/3 ms)
SyCH
Convolutional Decoder
K=9
R=1/2
816
Sampler
÷ 2
818
Block Deinterleaver
AxB=128
819
Sampler
÷ 4
1.2
2.4
4.8
4.8
19.2
824
826
828
820
Paging
96
192
PgCH
Convolutional Decoder
K=9
R=1/2
Sampler
÷ 2
÷ 1
Block Deinterleaver
AxB=384
4.8
9.6
9.6
19.2
19.2
19.2
830
Traffic
172
80
40
16
TCH
831
CRC
-12
-8
-0
-0
832
Tail Bits
-8
834
Convolutional Dncoder
K=9
R=1/2
836
Sampler
÷ 1
÷ 2
÷ 4
÷ 8
838
Block Deinterleaver
AxB=384
9.6
4.8
2.4
1.2
19.2
9.6
4.8
2.4
19.2
19.2

FIG. 8

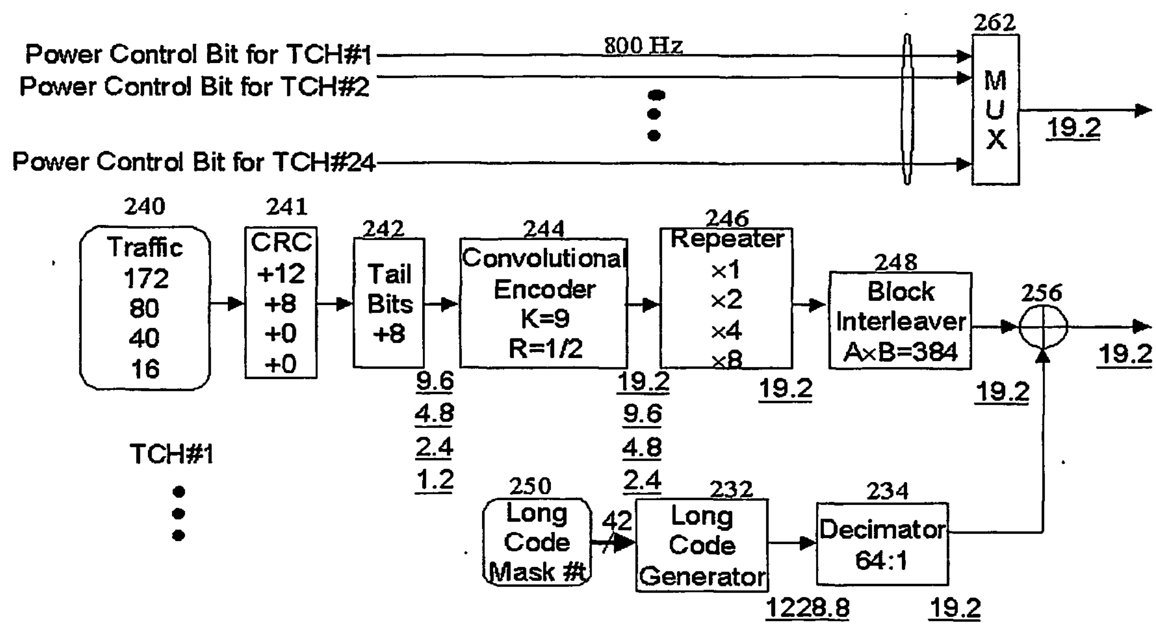

Power Control Bit for TCH#1
Power Control Bit for TCH#2
Power Control Bit for TCH#24
800 Hz
262
MUX
19.2
240
Traffic
172
80
40
16
241
CRC
+12
+8
+0
+0
242
Tail Bits
+8
244
Convolutional Encoder
K=9
R=1/2
246
Repeater
×1
×2
×4
×8
248
Block Interleaver
A×B=384
256
19.2
9.6
4.8
2.4
1.2
19.2
9.6
4.8
2.4
19.2
19.2
TCH#1
250
Long Code Mask #
42
232
Long Code Generator
234
Decimator
64:1
1228.8
19.2

FIG. 9a

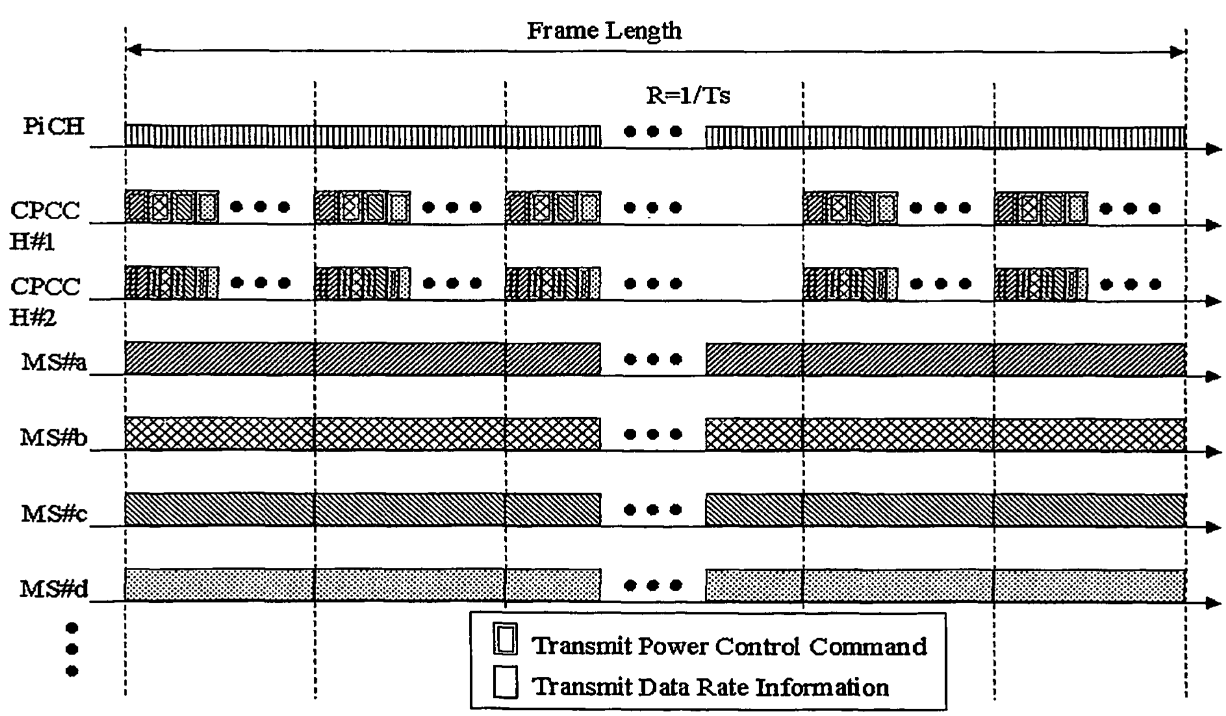

Frame Length
R=1/Ts
PiCH
CPCCH#1
CPCCH#2
MS#a
MS#b
MS#c
MS#d
Transmit Power Control Command
Transmit Data Rate Information

FIG. 9b

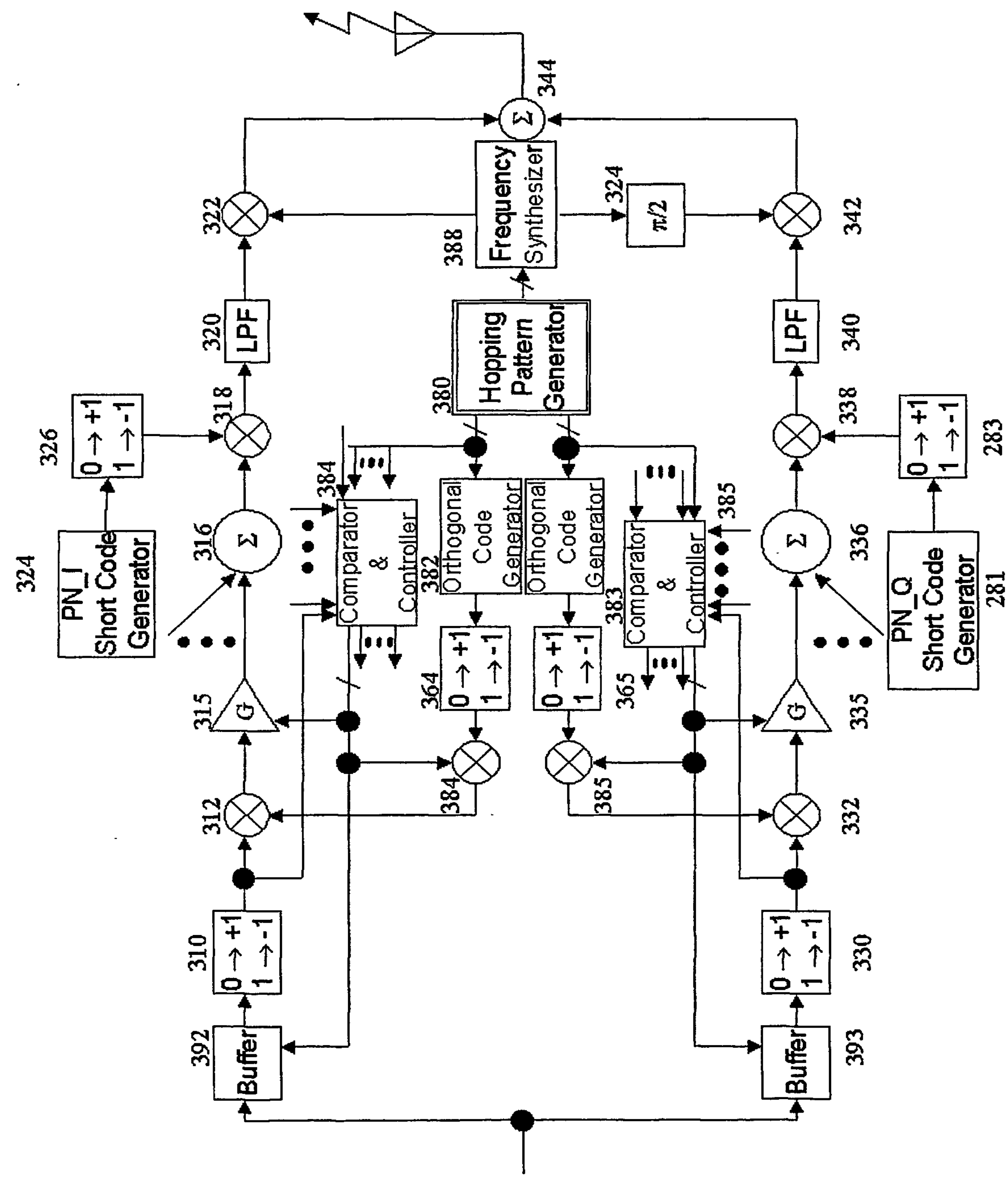
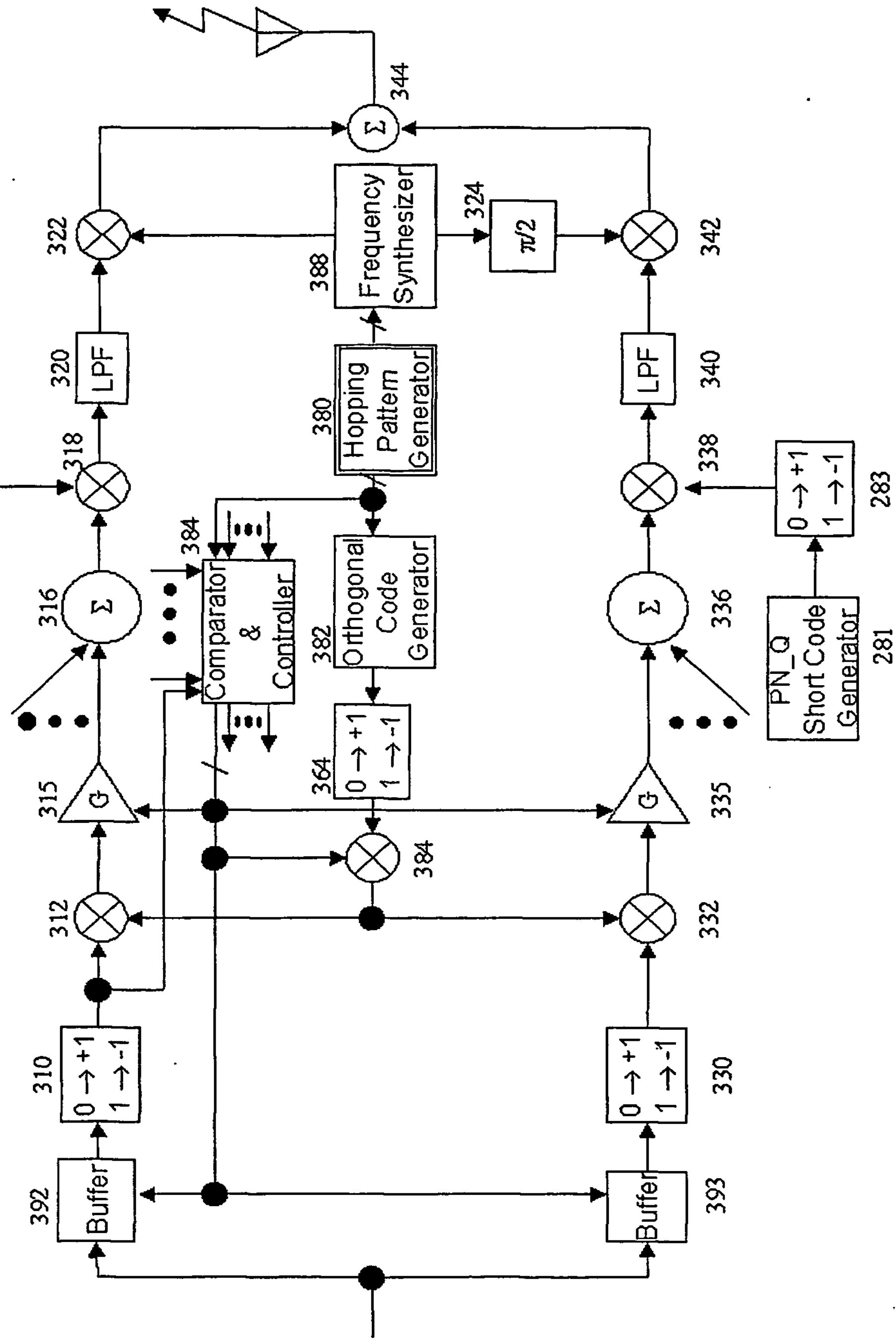

Buffer
392
Buffer
393
0 → +1
1 → -1
310
330
312
332
G
315
335
Σ
316
336
318
338
326
283
LPF
320
340
322
342
Frequency Synthesizer
388
π/2
324
Σ
344
Hopping Pattern Generator
380
Orthogonal Code Generator
382
383
Comparator & Controller
384
385
364
365
PN_I Short Code Generator
324
PN_Q Short Code Generator
281

FIG. 10a



Buffer
392
Buffer
393
0 → +1
1 → -1
310
0 → +1
1 → -1
330
312
332
G
315
G
335
384
0 → +1
1 → -1
364
Σ
316
Σ
336
Comparator
&
Controller
384
Orthogonal
Code
Generator
382
Hopping
Pattern
Generator
380
Frequency
Synthesizer
388
324
π/2
PN_I
Short Code
Generator
324
0 → +1
1 → -1
326
318
LPF
320
322
PN_Q
Short Code
Generator
281
0 → +1
1 → -1
283
338
LPF
340
342
Σ
344

FIG. 10b

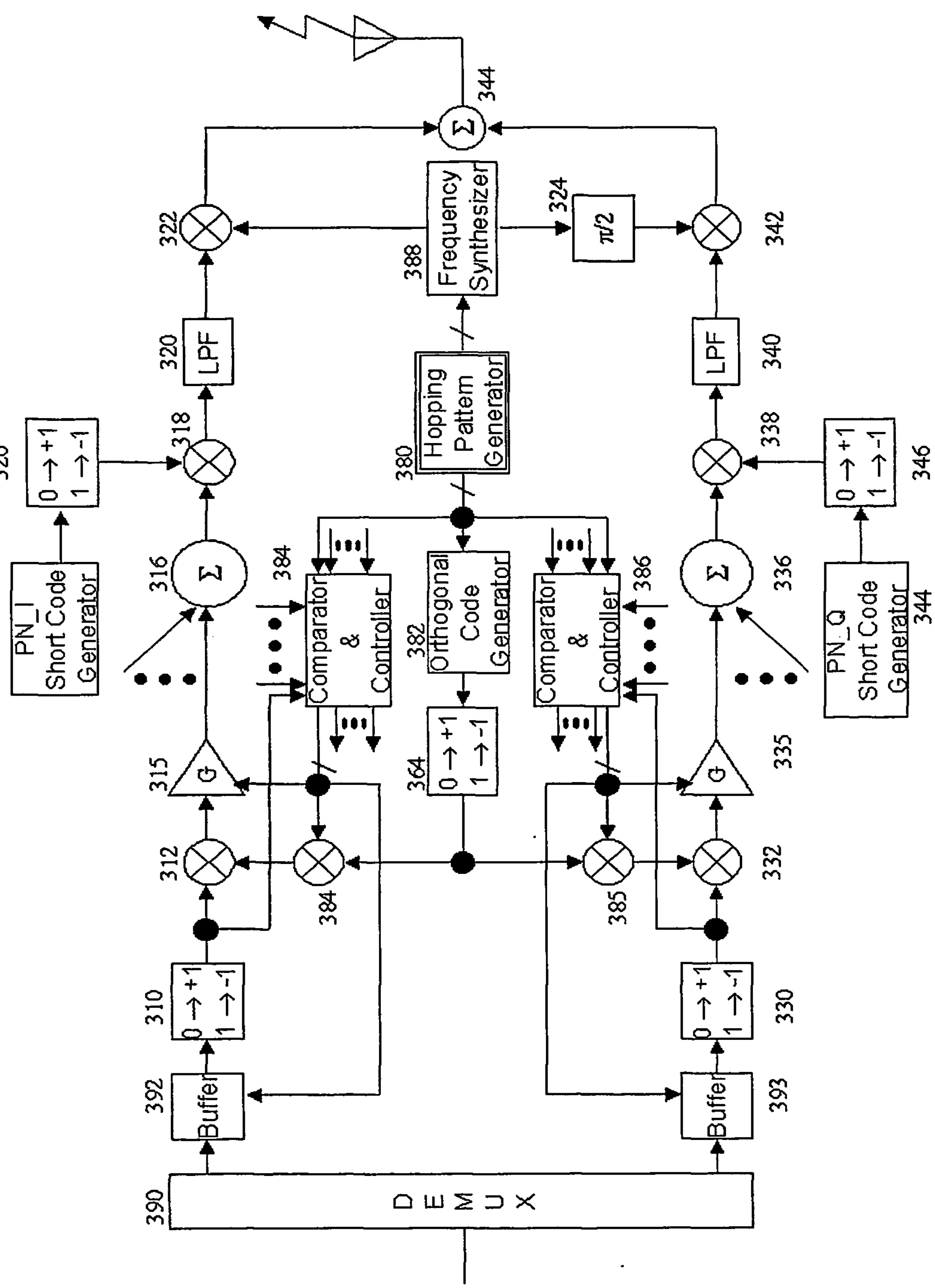

344
388
Frequency Synthesizer
324
π/2
322
342
320
LPF
340
LPF
380
Hopping Pattern Generator
326
0 → +1
1 → -1
318
338
346
0 → +1
1 → -1
324
PN_I Short Code Generator
316
Σ
384
Comparator & Controller
382
Orthogonal Code Generator
Comparator & Controller
386
336
Σ
PN_Q Short Code Generator
344
315
G
364
0 → +1
1 → -1
335
G
312
384
385
332
310
0 → +1
1 → -1
330
0 → +1
1 → -1
392
Buffer
393
Buffer
390
DEMUX

FIG. 10c

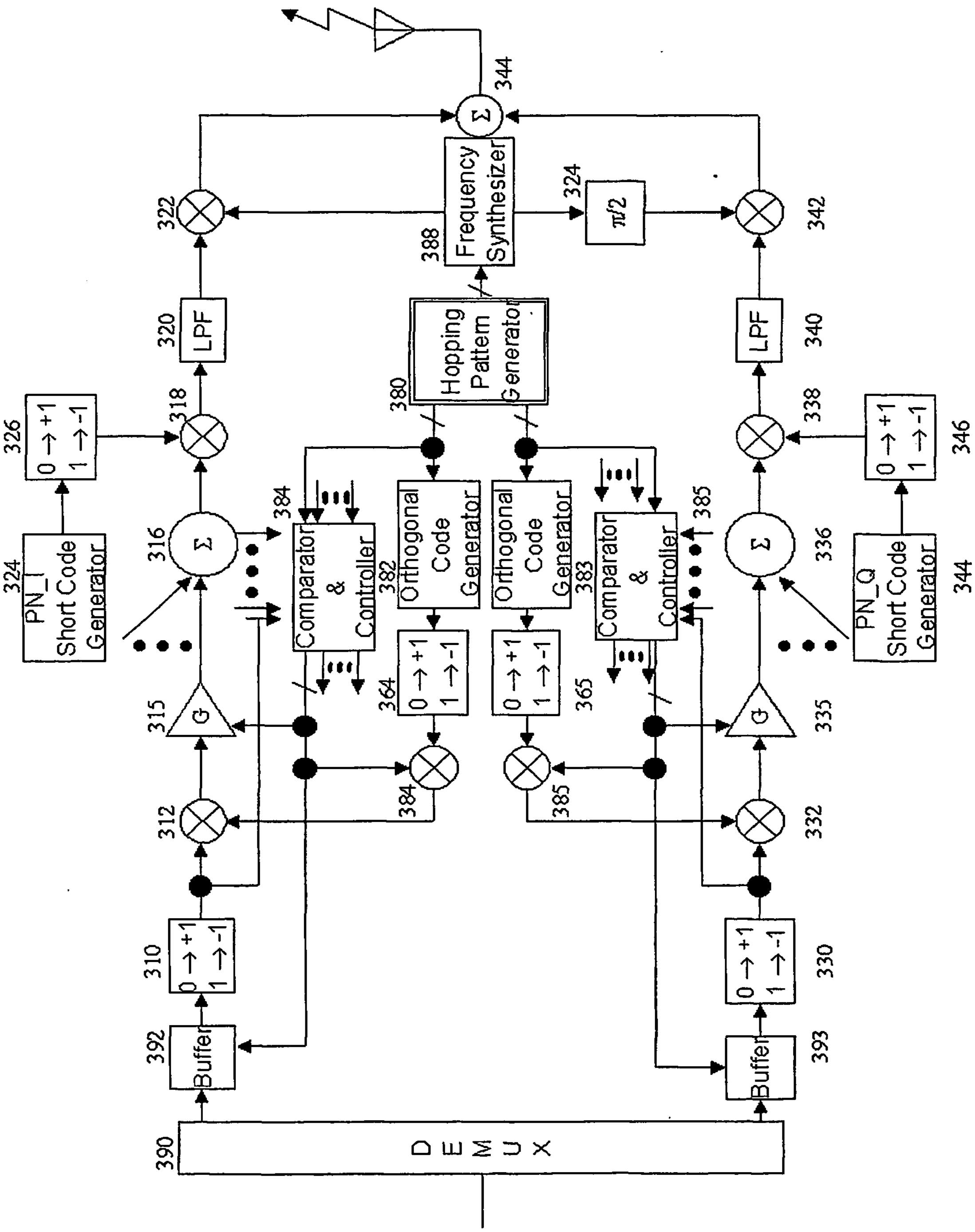

344
Σ
388
Frequency Synthesizer
324
π/2
322
342
380
Hopping Pattern Generator
320
LPF
340
LPF
318
338
326
0 → +1
1 → -1
346
0 → +1
1 → -1
324
PN_I Short Code Generator
344
PN_Q Short Code Generator
316
Σ
336
Σ
384
Comparator & Controller
385
Comparator & Controller
382
Orthogonal Code Generator
383
Orthogonal Code Generator
364
0 → +1
1 → -1
365
0 → +1
1 → -1
315
G
335
G
384
385
312
332
310
0 → +1
1 → -1
330
0 → +1
1 → -1
392
Buffer
393
Buffer
390
DEMUX

FIG. 10d

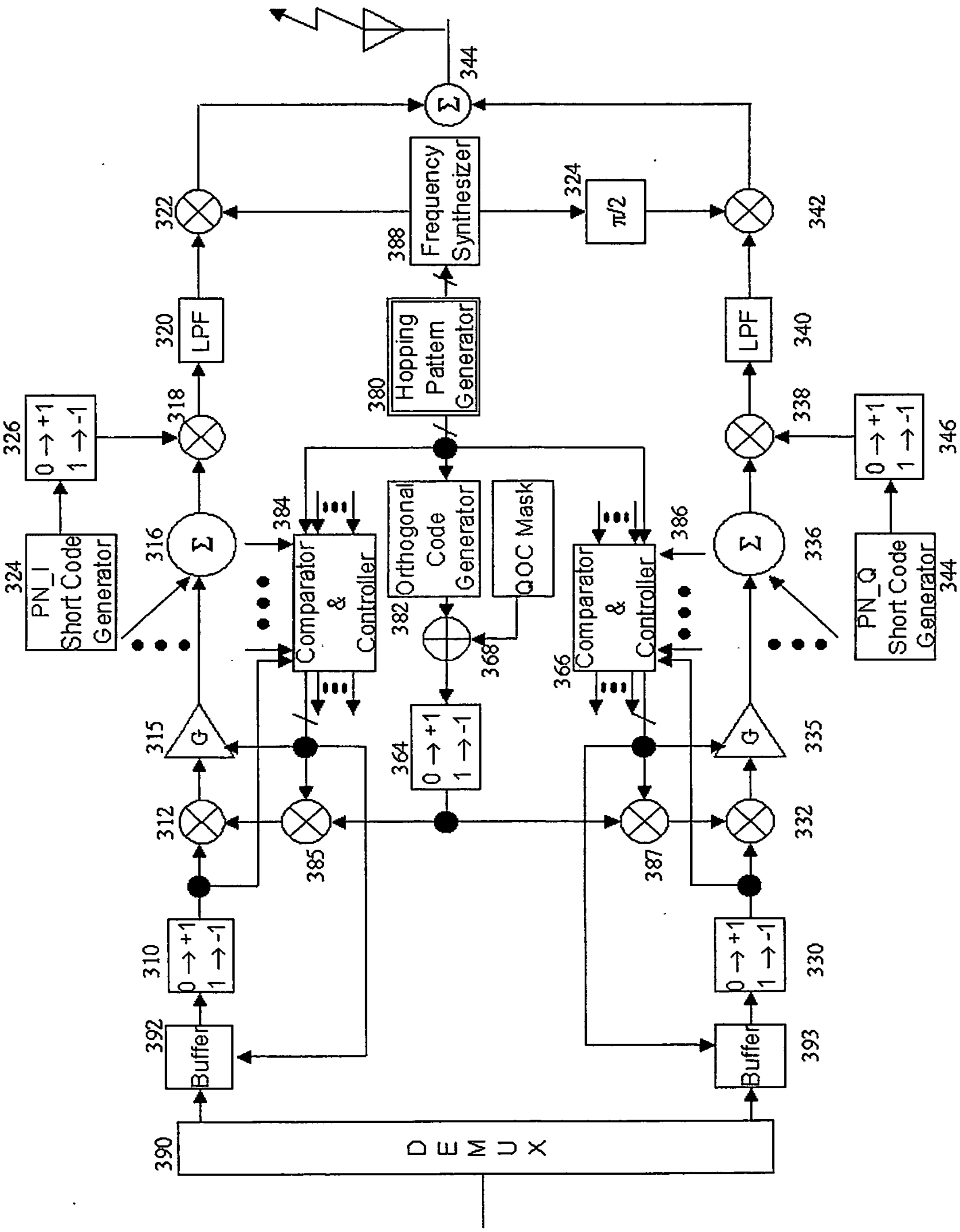

344
Frequency Synthesizer
388
324
π/2
322
342
320
LPF
340
LPF
380
Hopping Pattern Generator
326
0 → +1
1 → -1
318
338
346
324
PN_I Short Code Generator
316
384
Comparator & Controller
Orthogonal Code Generator
382
QOC Mask
368
Comparator & Controller
366
386
336
PN_Q Short Code Generator
344
315
G
364
335
312
385
387
332
310
330
392
Buffer
393
Buffer
390
DEMUX

FIG. 10e

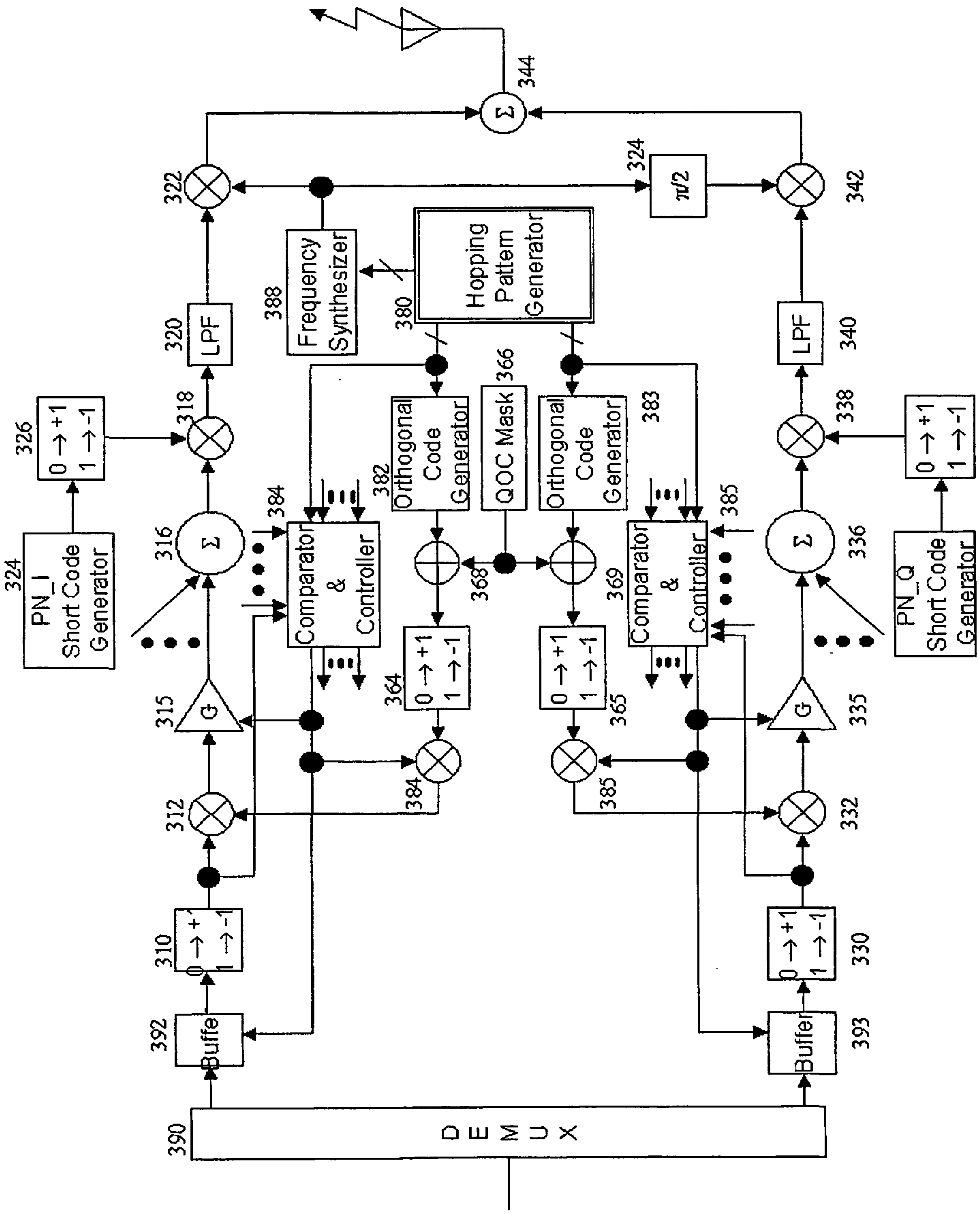

344
Σ
322
324
π/2
342
388
Frequency Synthesizer
380
Hopping Pattern Generator
320
LPF
340
LPF
326
0 → +1
1 → -1
318
366
QOC Mask
382
Orthogonal Code Generator
383
Orthogonal Code Generator
338
346
0 → +1
1 → -1
324
PN_I Short Code Generator
316
Σ
384
Comparator & Controller
368
369
Comparator & Controller
385
336
Σ
344
PN_Q Short Code Generator
315
G
364
0 → +1
1 → -1
365
0 → +1
1 → -1
335
G
312
384
385
332
310
0 → +1
1 → -1
330
0 → +1
1 → -1
392
Buffer
393
Buffer
390
DEMUX

FIG. 10f

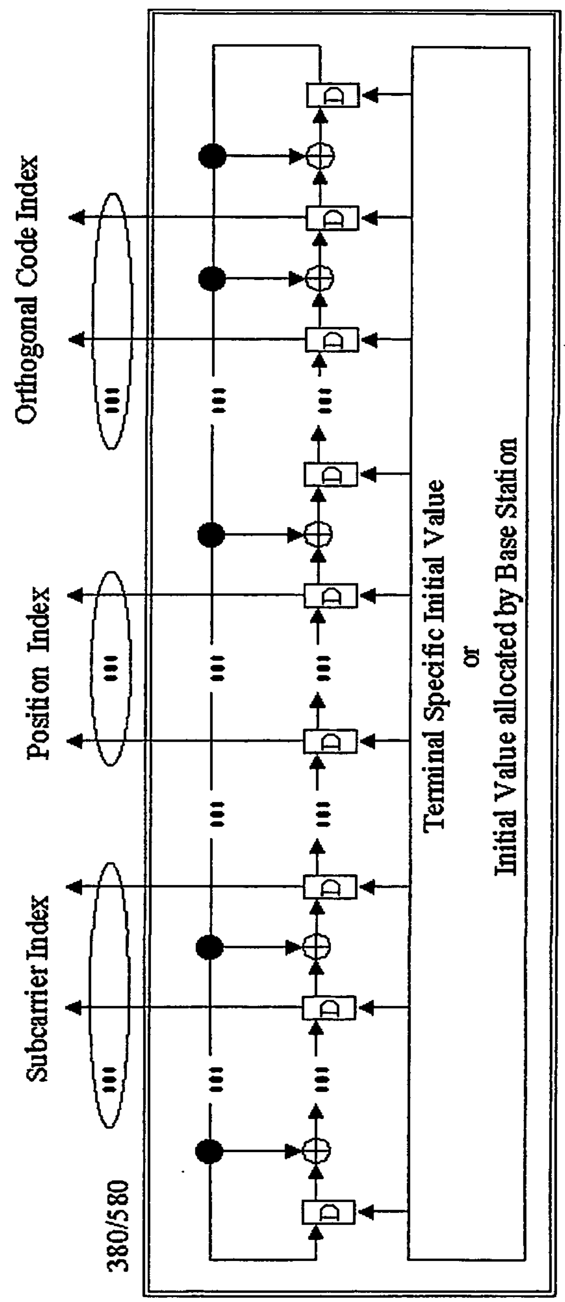

Orthogonal Code Index
Position Index
Subcarrier Index
380/580
Terminal Specific Initial Value
or
Initial Value allocated by Base Station
D

FIG. 11

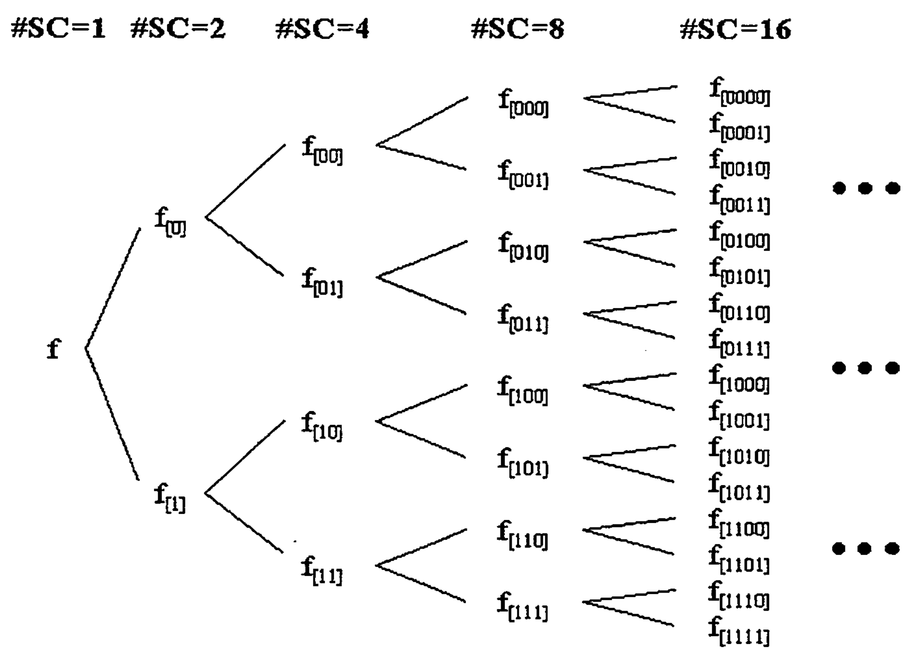


FIG. 12a

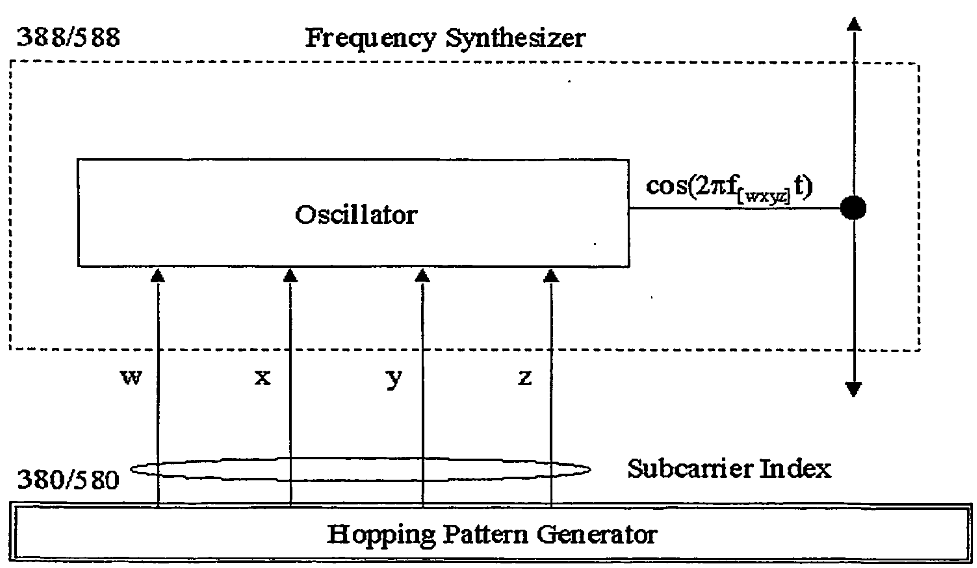


FIG. 12b

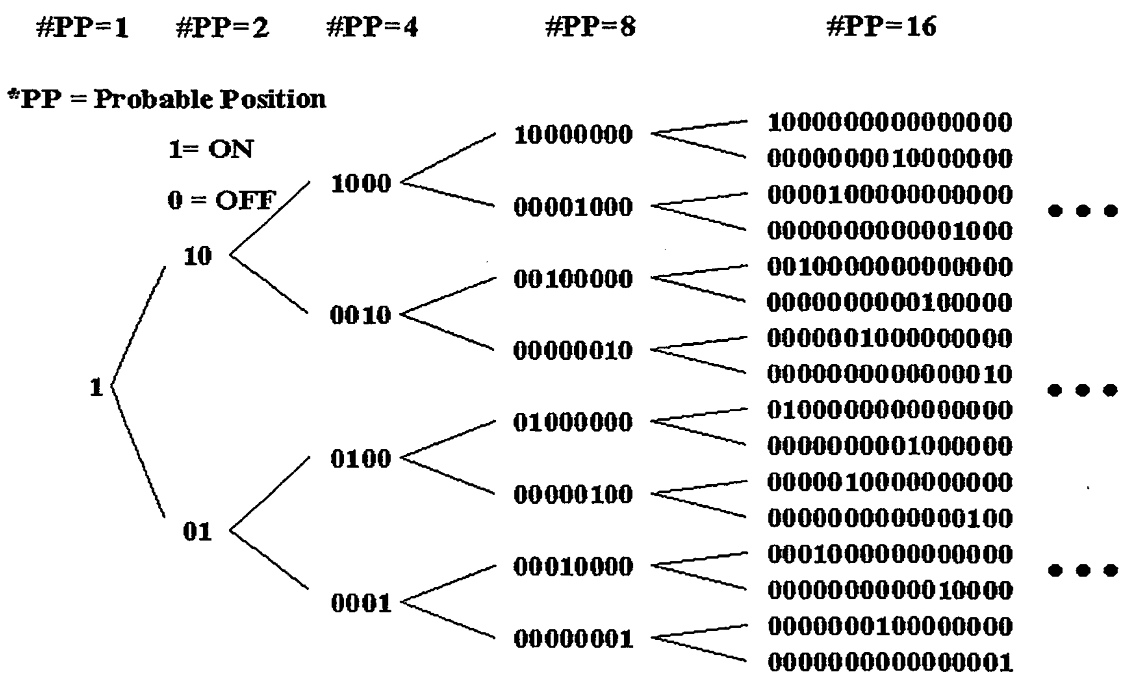

#PP=1
#PP=2
#PP=4
#PP=8
#PP=16
*PP = Probable Position
1= ON
0 = OFF
1
10
01
1000
0010
0100
0001
10000000
00001000
00100000
00000010
01000000
00000100
00010000
00000001
1000000000000000
0000000010000000
0000100000000000
0000000000001000
0010000000000000
0000000000100000
0000001000000000
0000000000000010
0100000000000000
0000000001000000
0000010000000000
0000000000000100
0001000000000000
0000000000010000
0000000100000000
0000000000000001

FIG. 12c

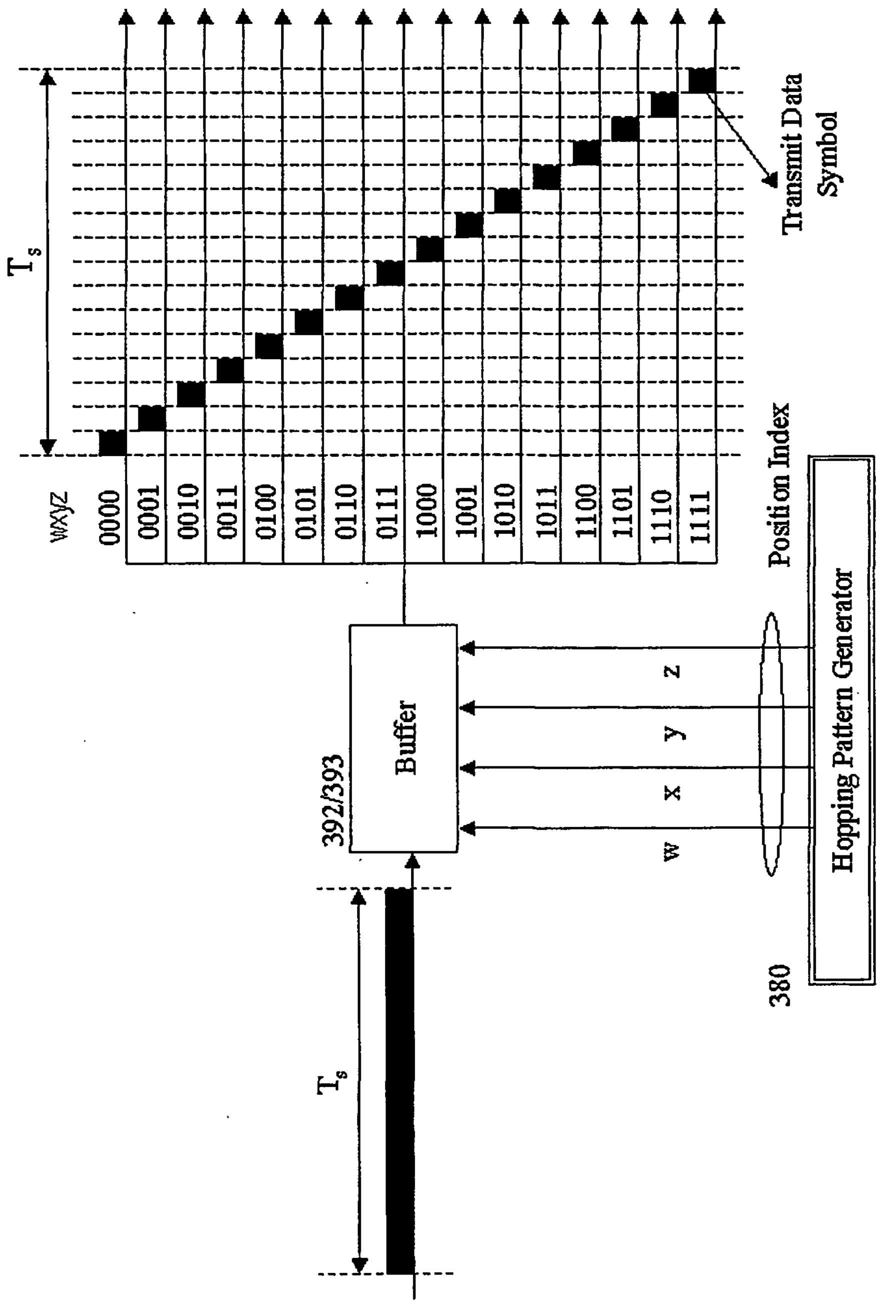

T_s
wxyz
0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1110
1111
Position Index
Transmit Data Symbol
Buffer
392/393
w
x
y
z
Hopping Pattern Generator
380
T_s

FIG. 12d

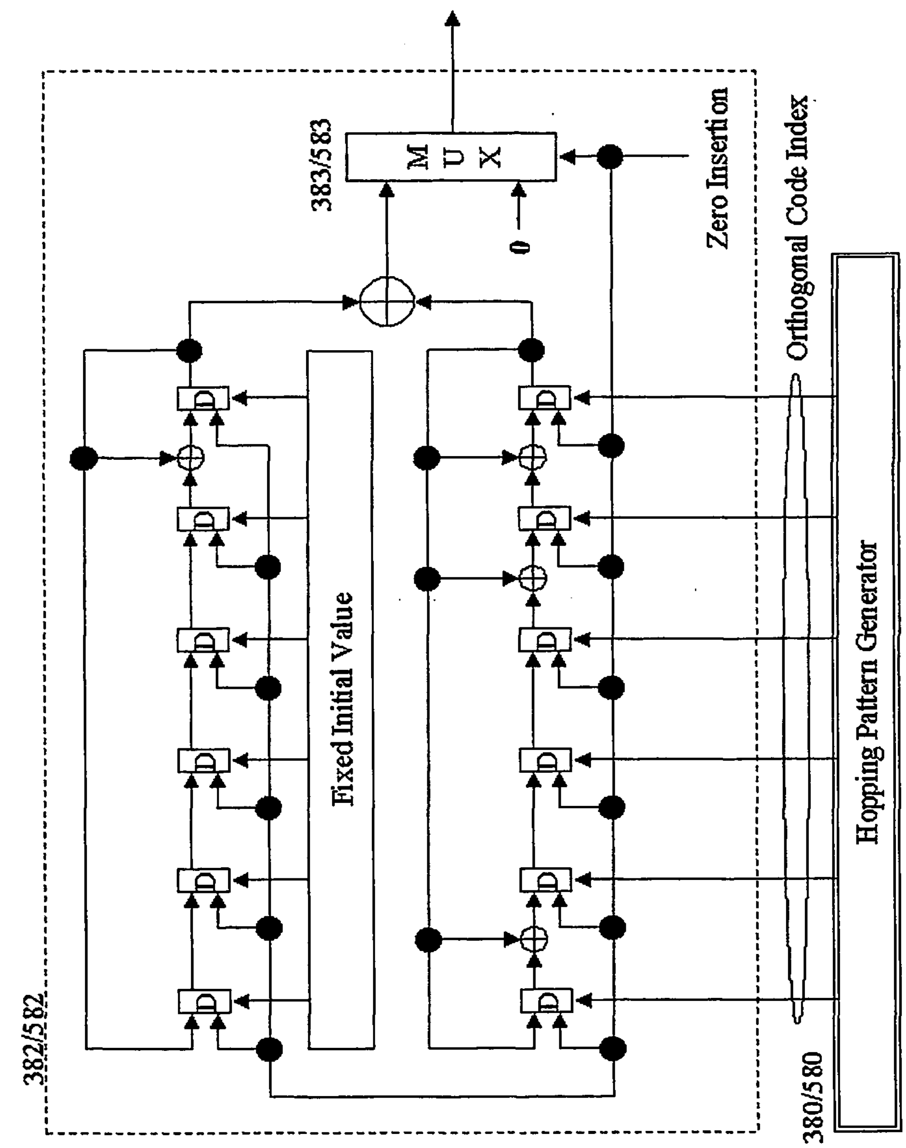

383/583
M
U
X
0
Zero Insertion
Orthogonal Code Index
Fixed Initial Value
Hopping Pattern Generator
382/582
380/580
D

FIG. 12e

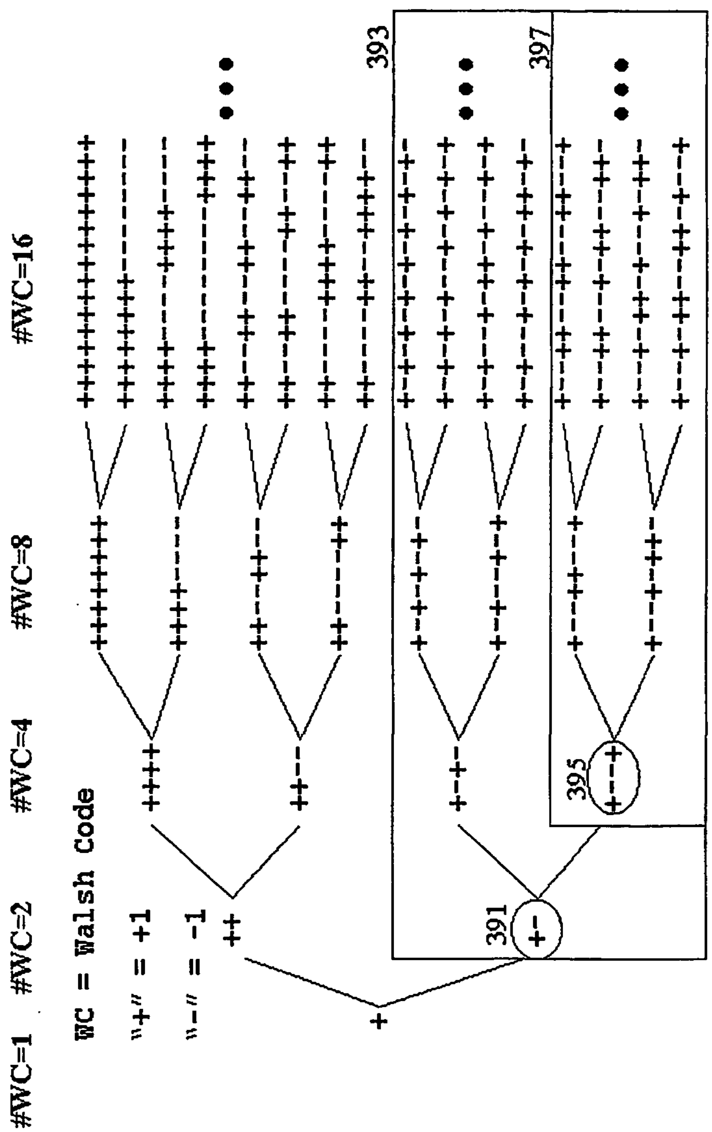


FIG. 12f

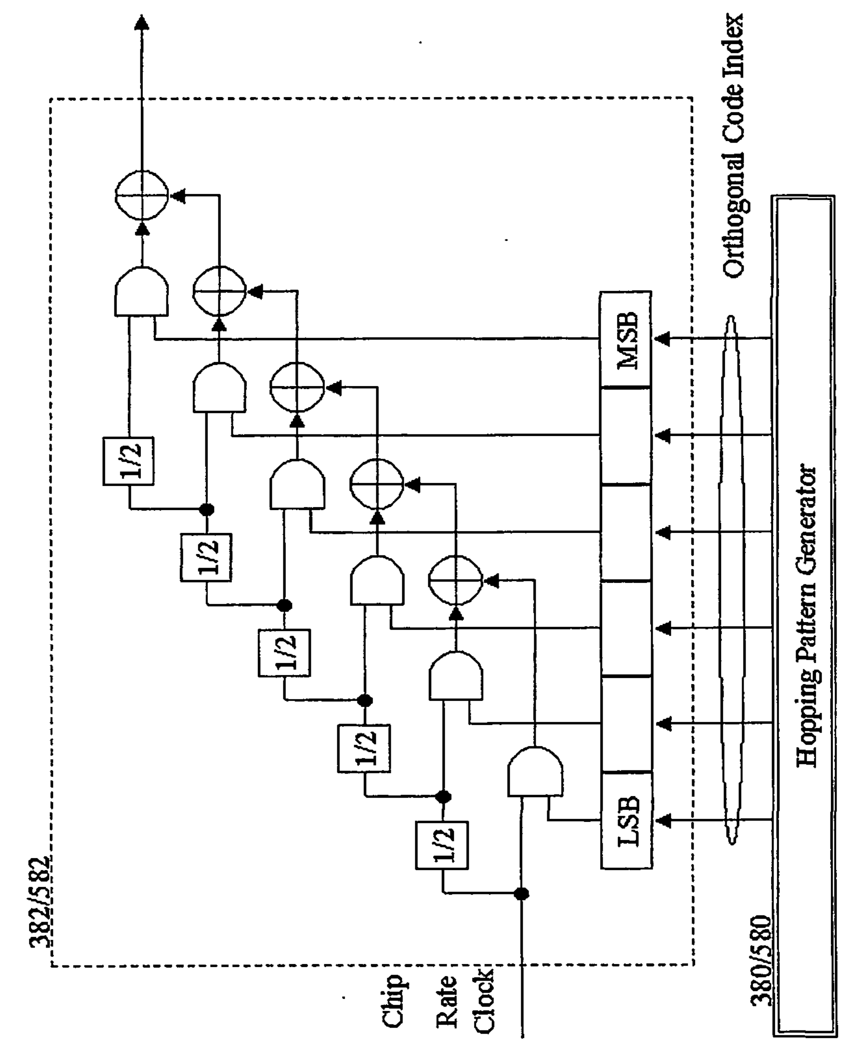

Orthogonal Code Index
Hopping Pattern Generator
MSB
LSB
1/2
1/2
1/2
1/2
1/2
382/582
380/580
Chip Rate Clock

FIG. 12g

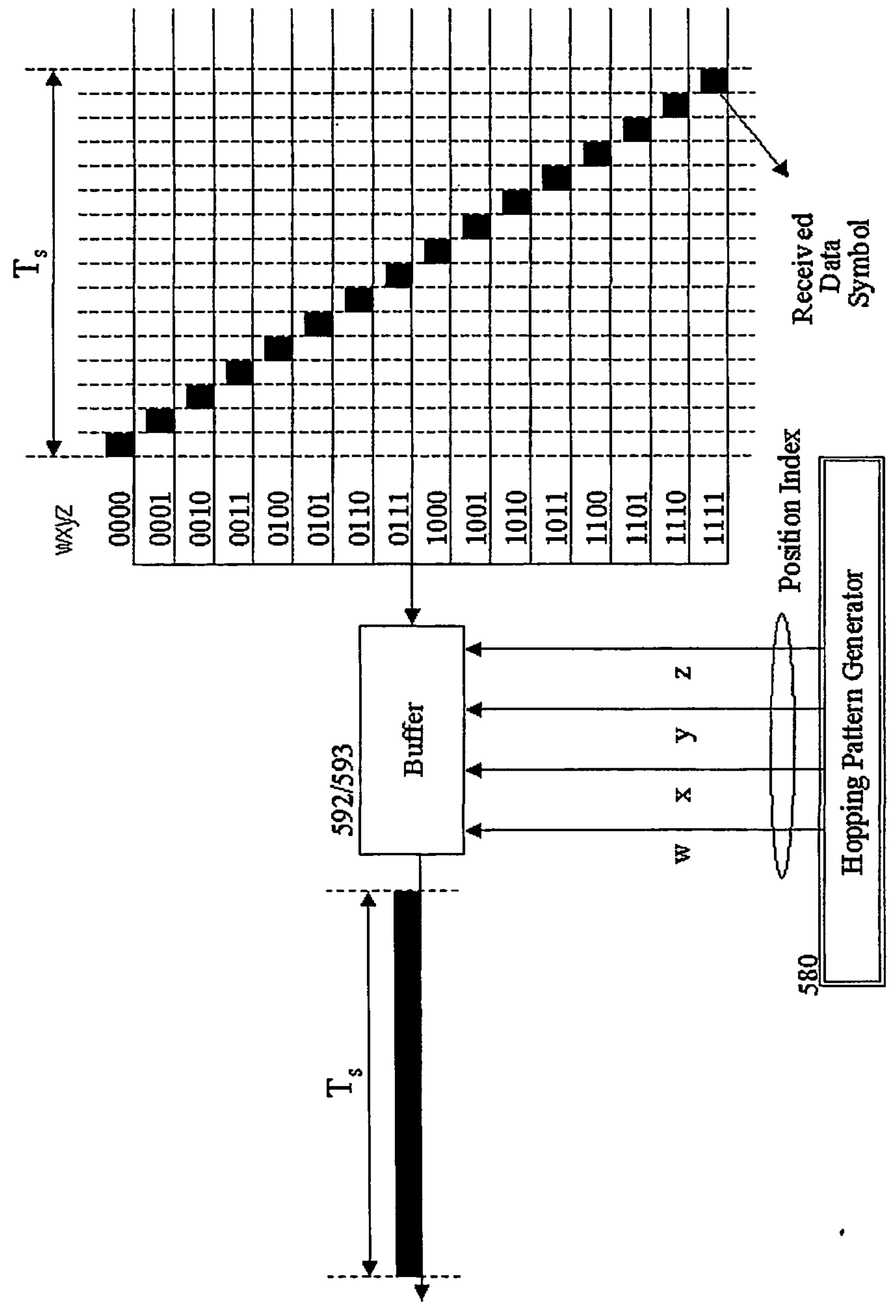

T_s
wxyz
0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1110
1111
Received Data Symbol
Position Index
592/593
Buffer
w
x
y
z
Hopping Pattern Generator
580
T_s

FIG. 12h

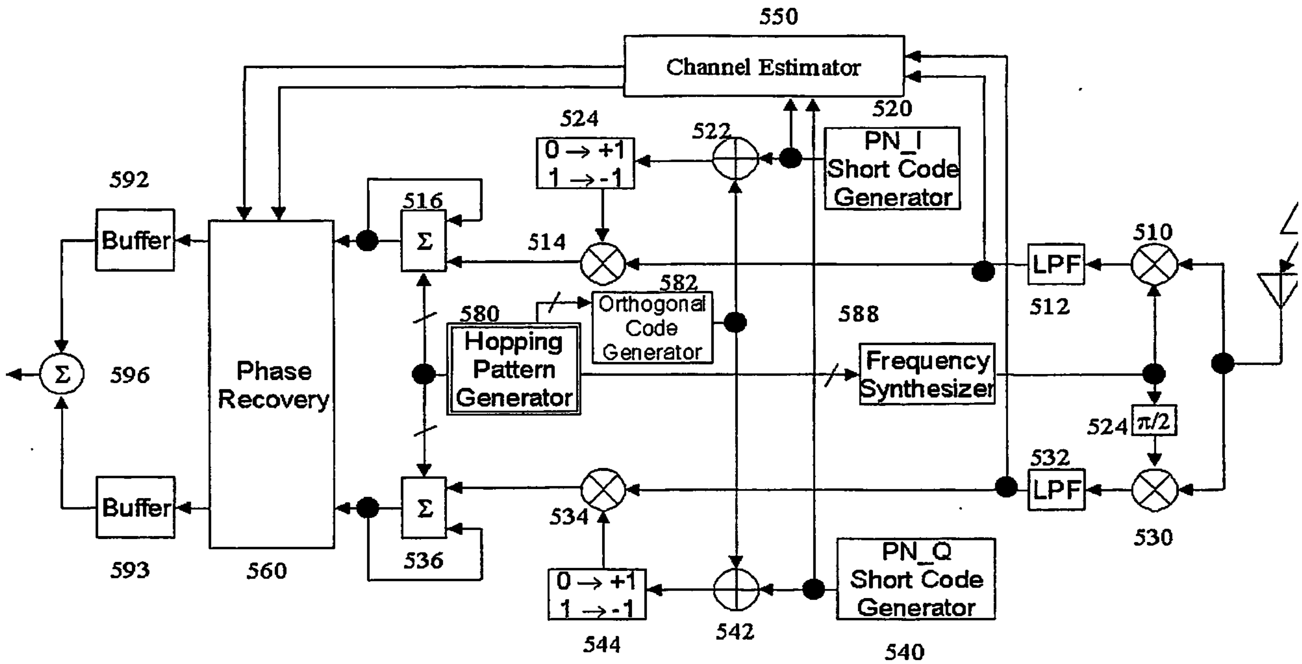


FIG. 13a

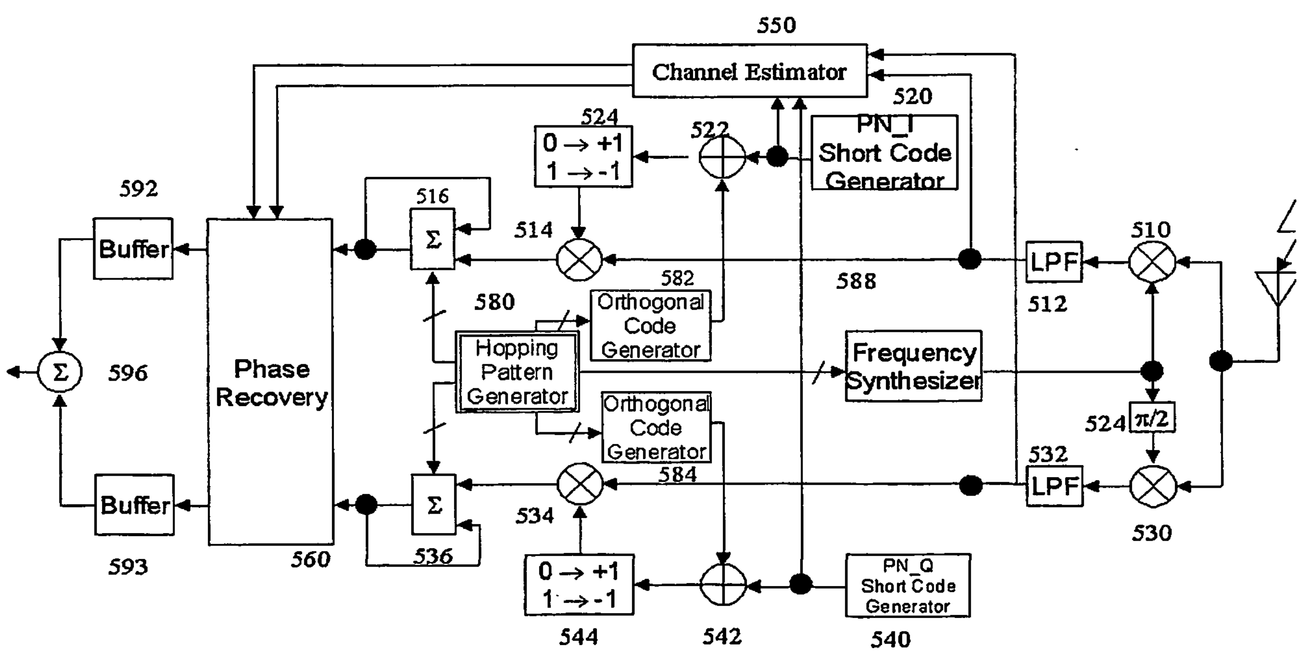


FIG. 13b

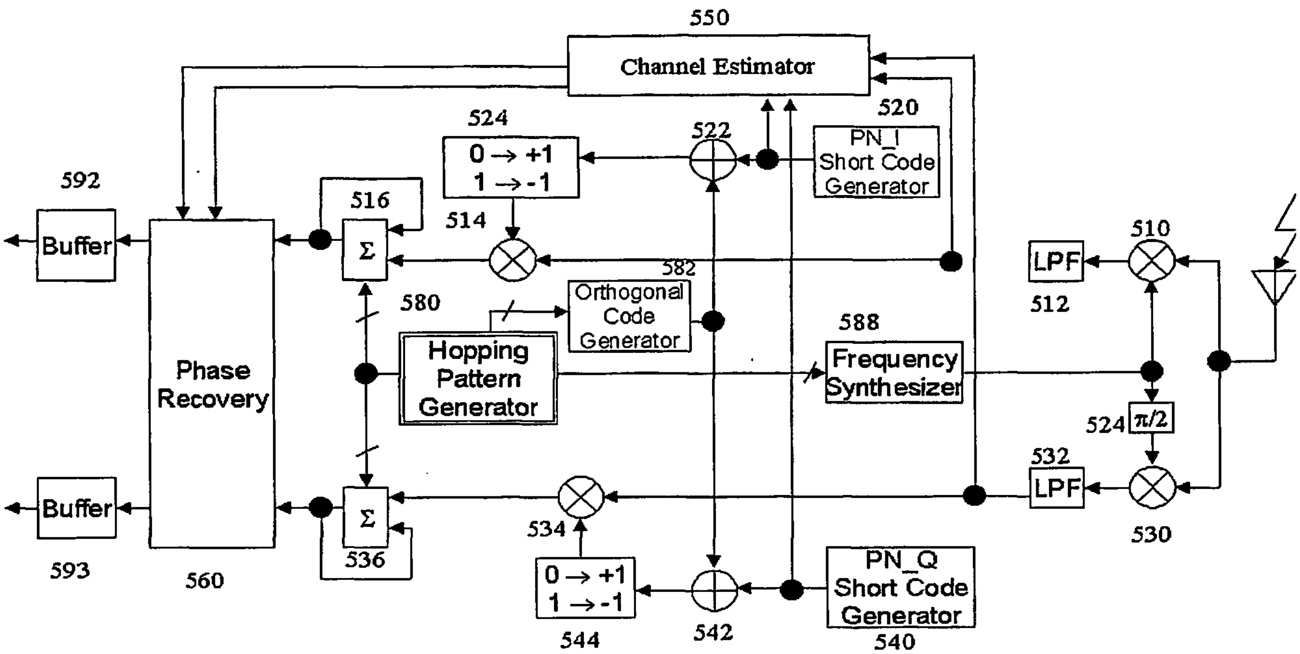


FIG. 13c

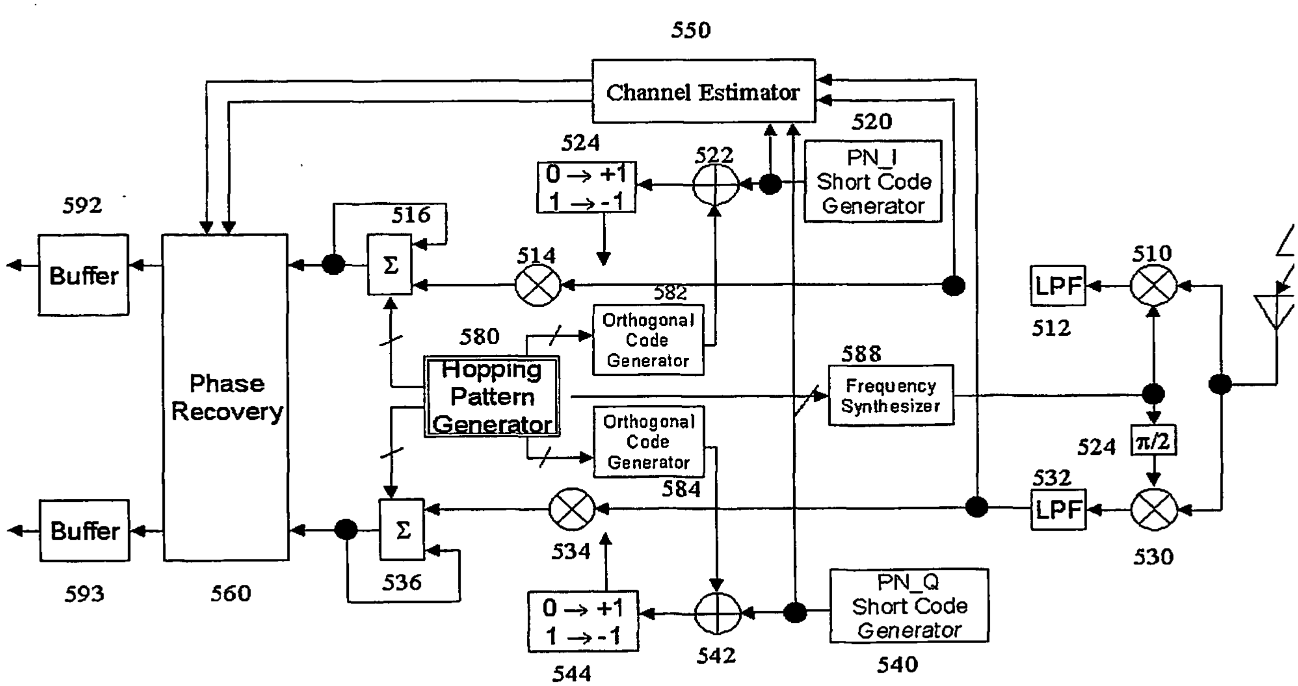


FIG. 13d

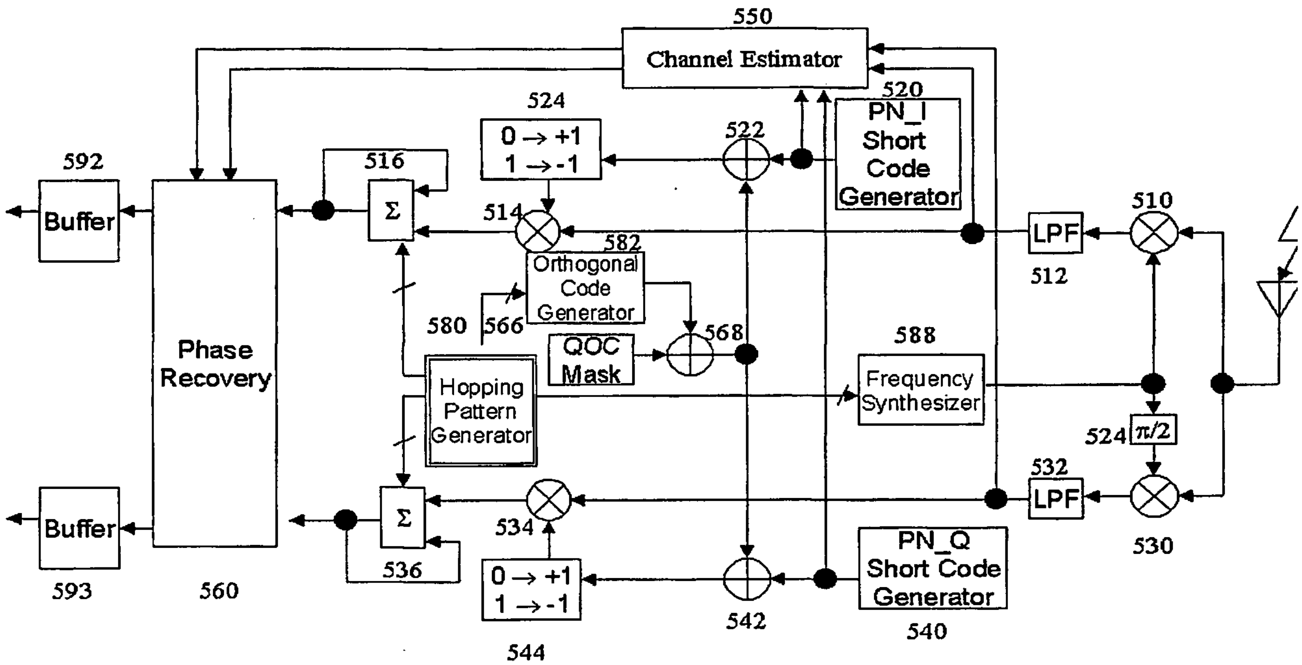


FIG. 13e

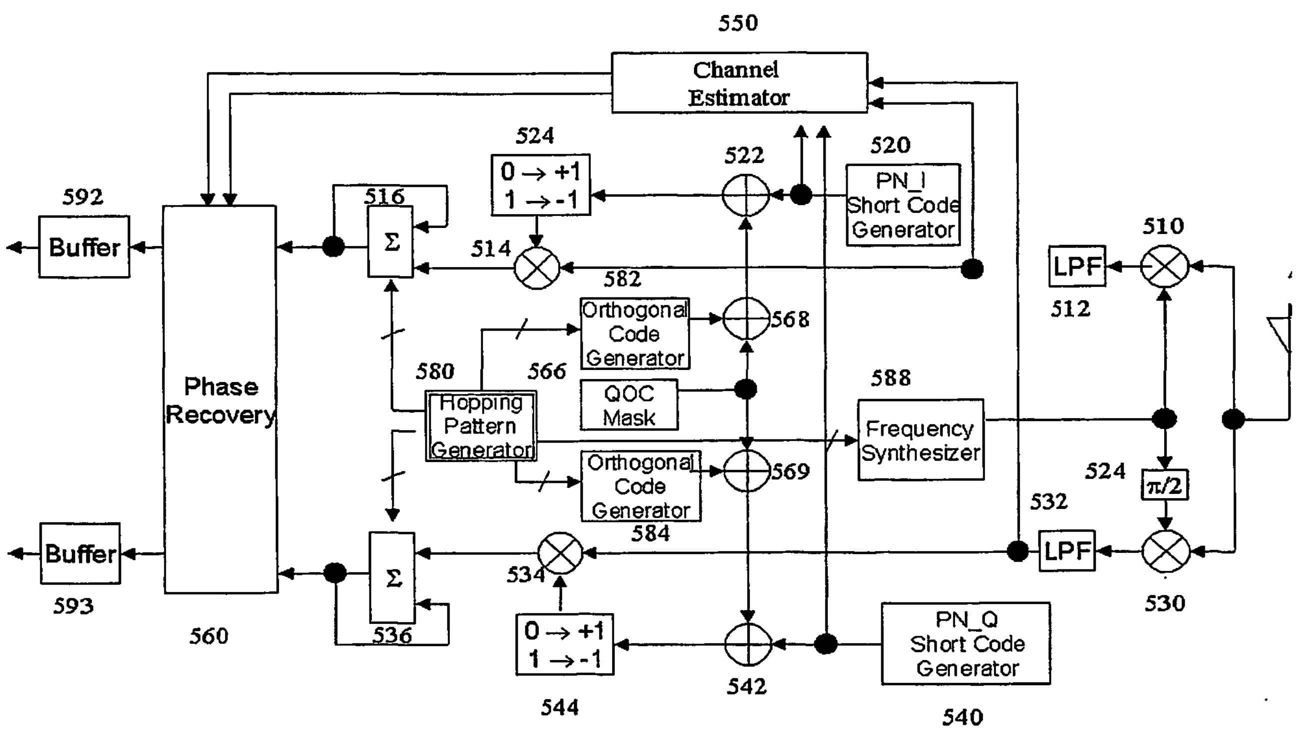


FIG. 13f

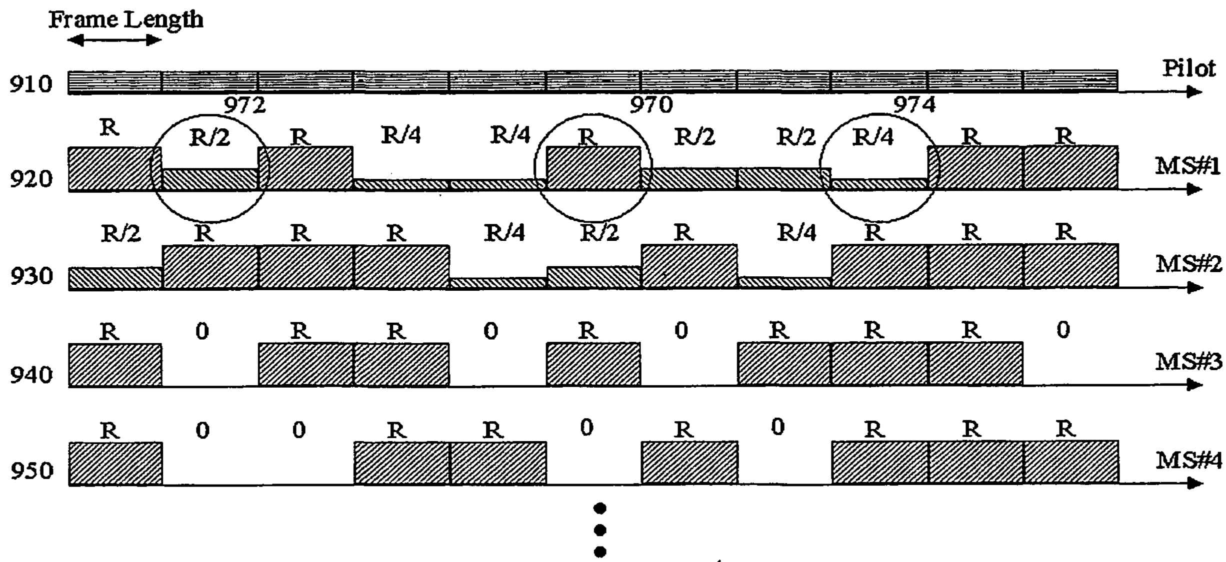


FIG. 14a

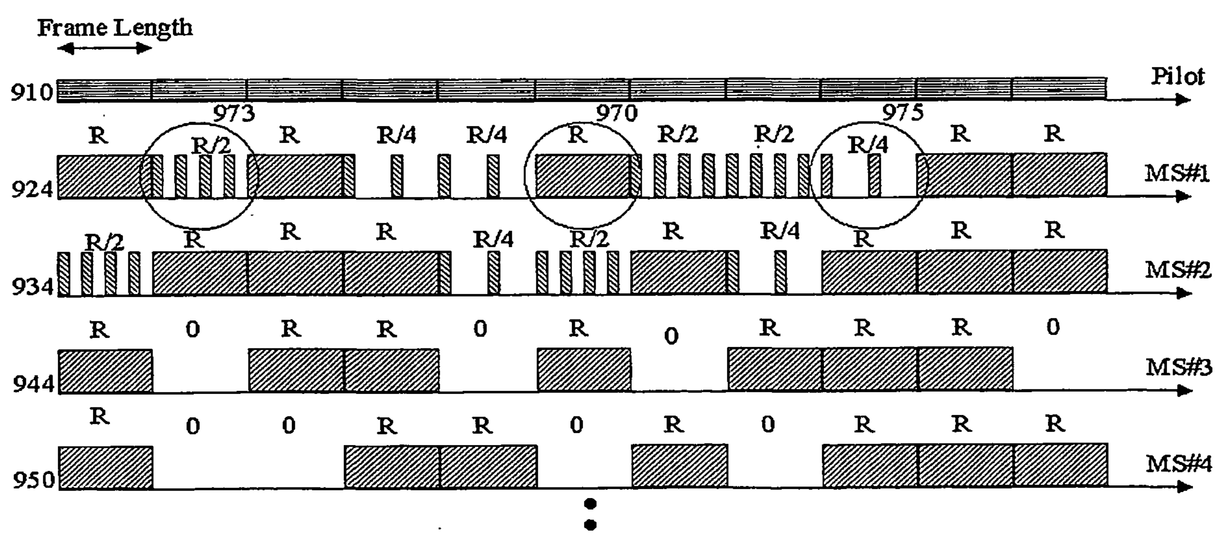


FIG. 14b

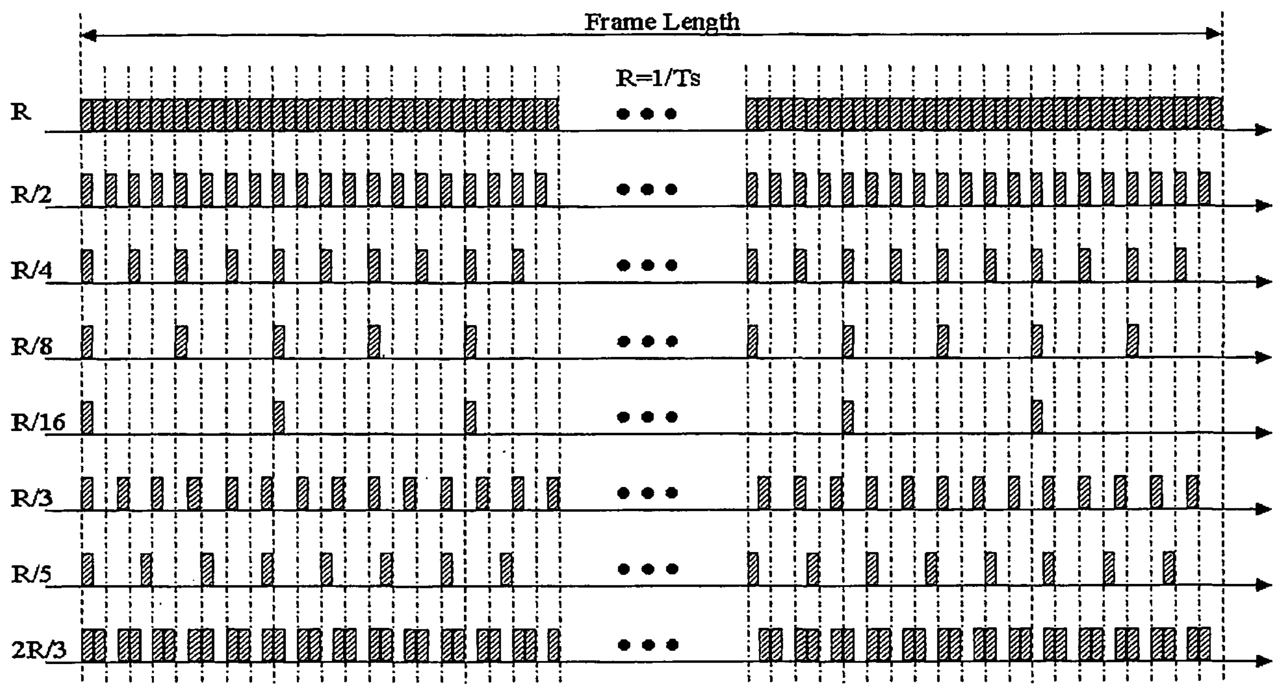


FIG. 14C

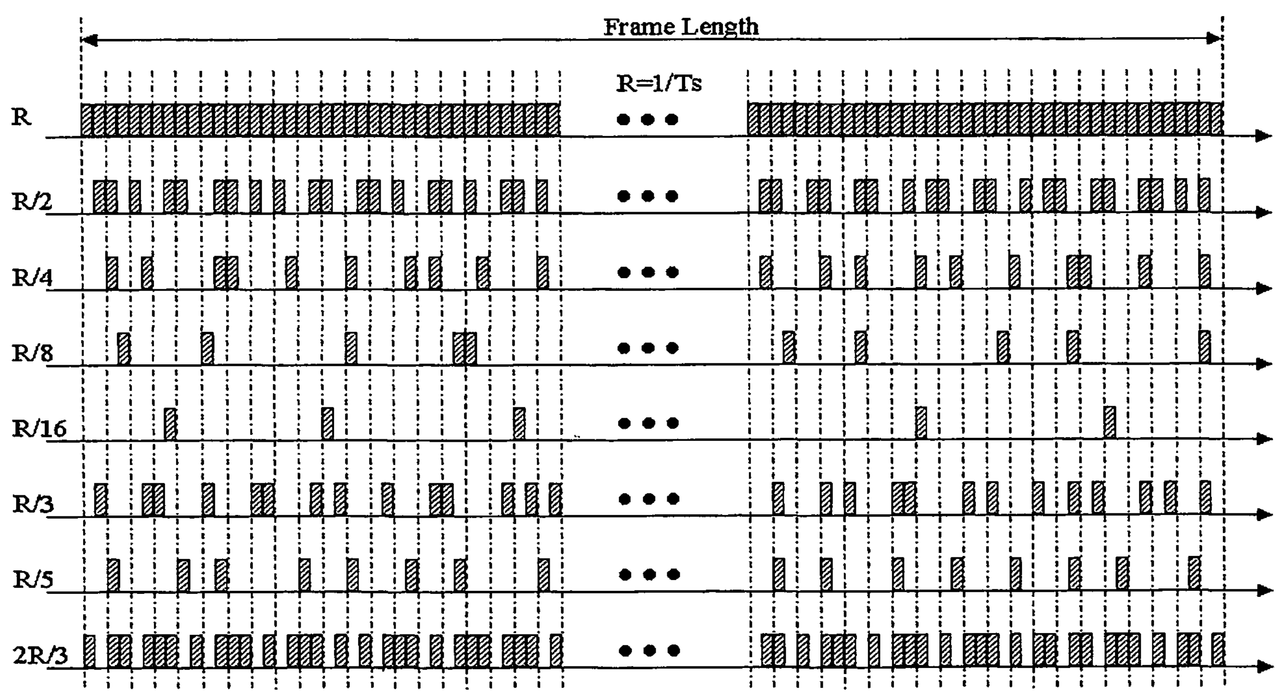


FIG. 14d

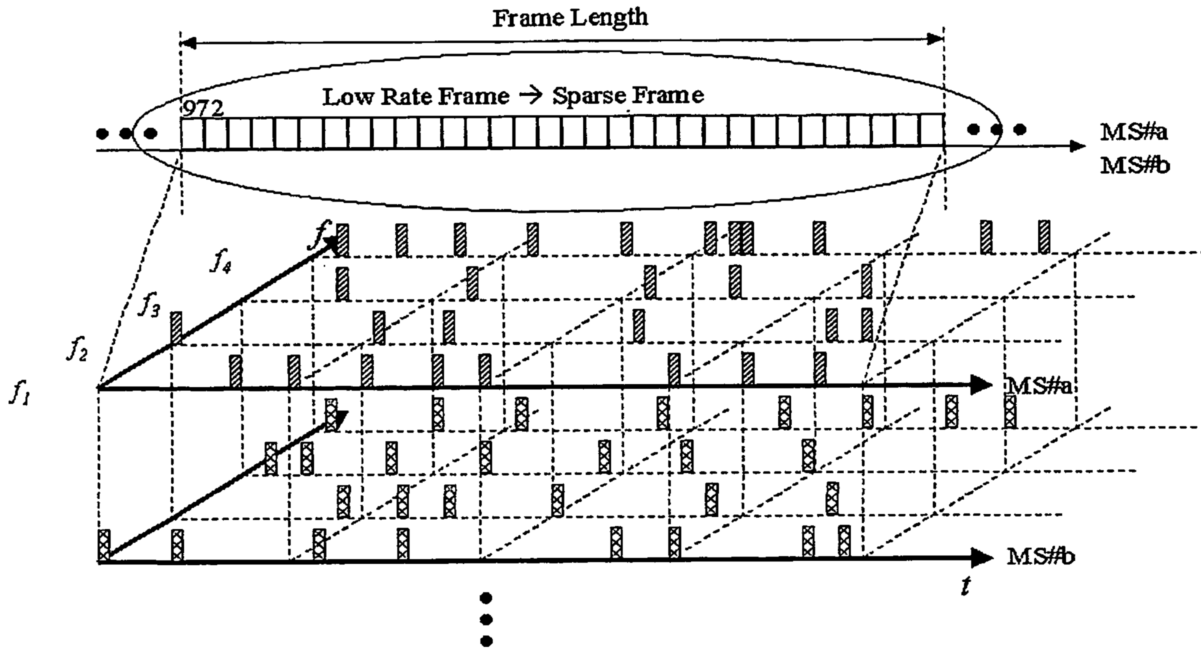


FIG. 14e

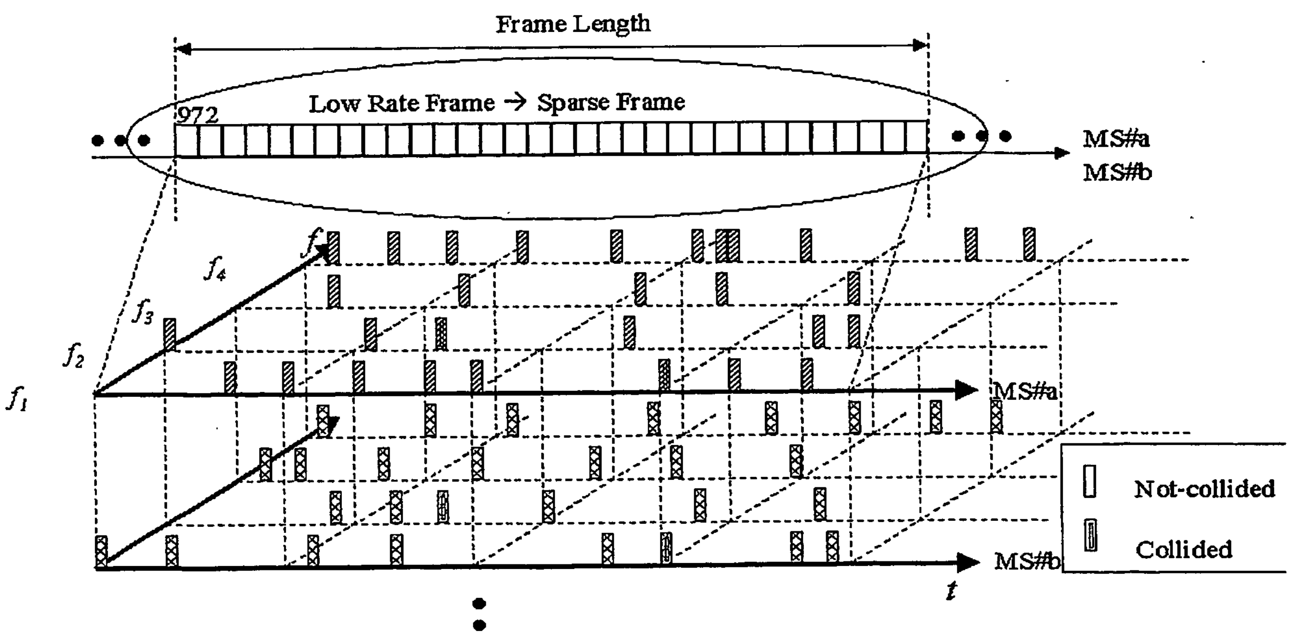


FIG. 14f

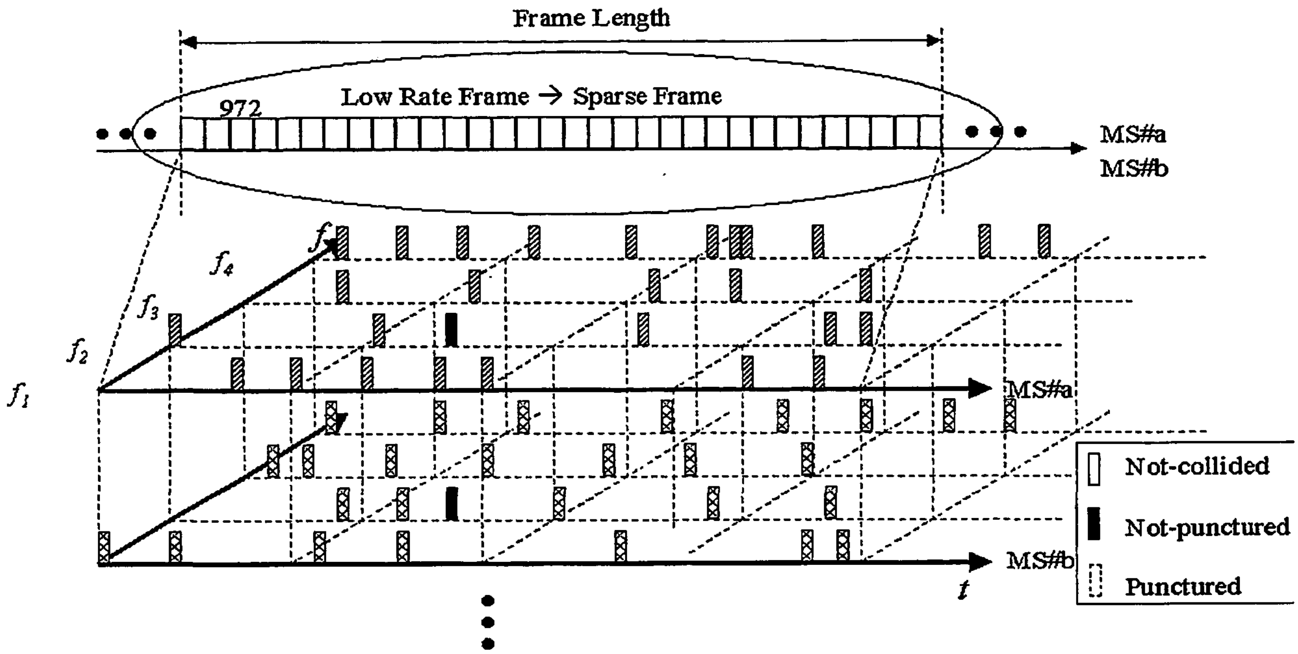


FIG. 14g

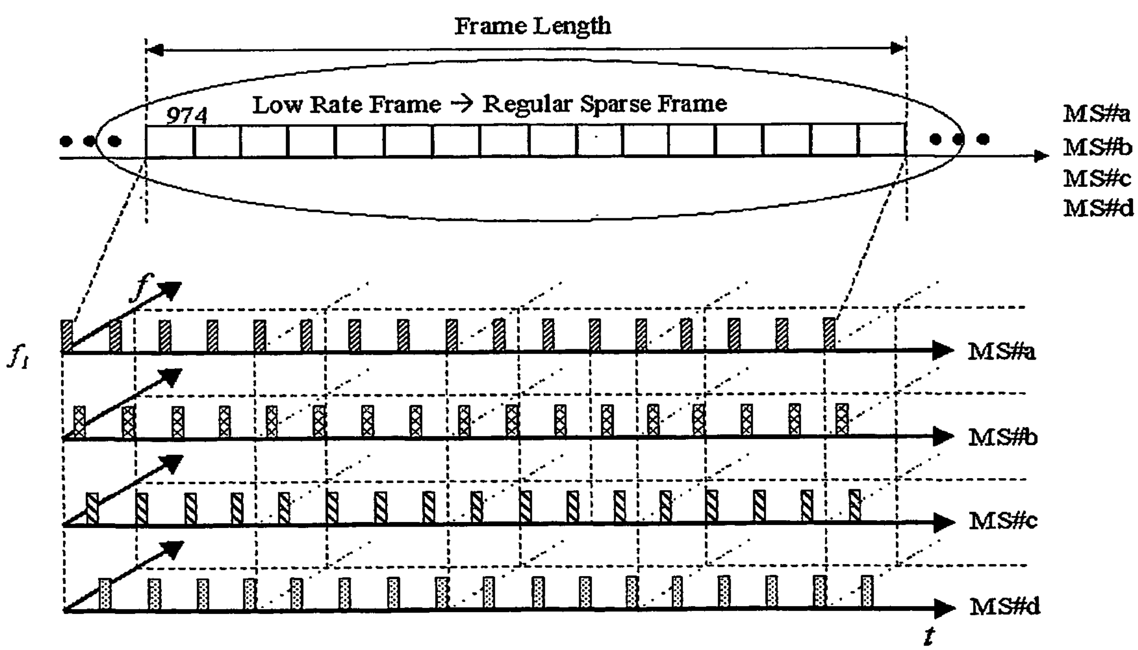


FIG. 14h

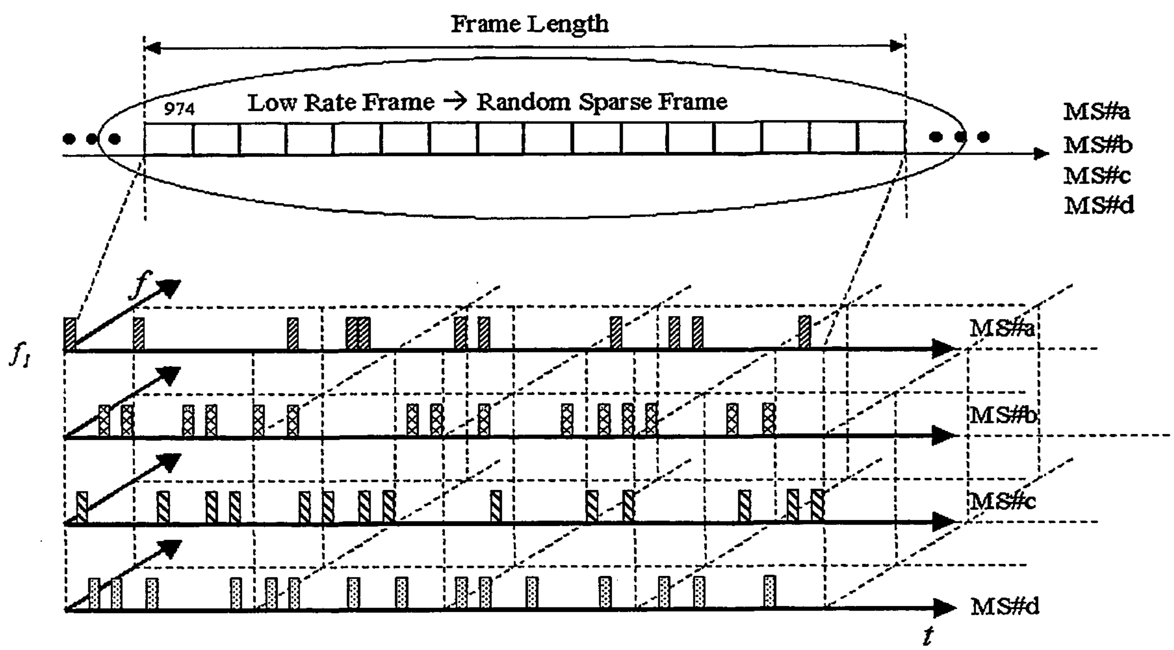


FIG. 14i

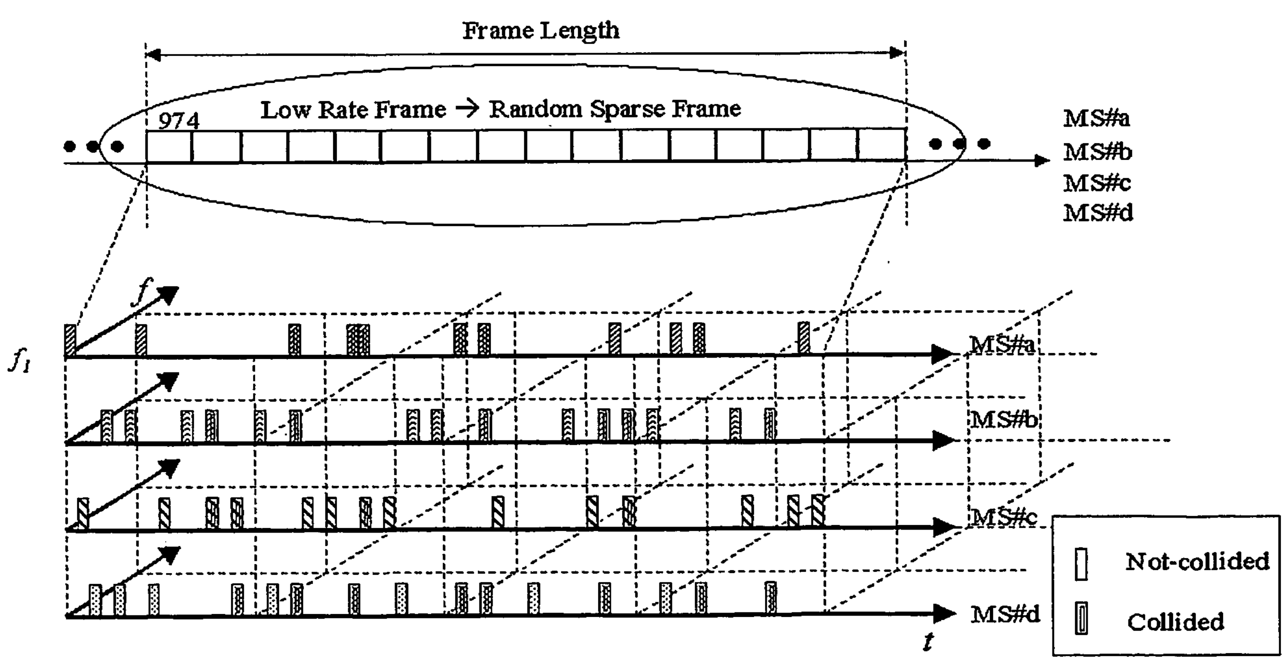


FIG. 14j

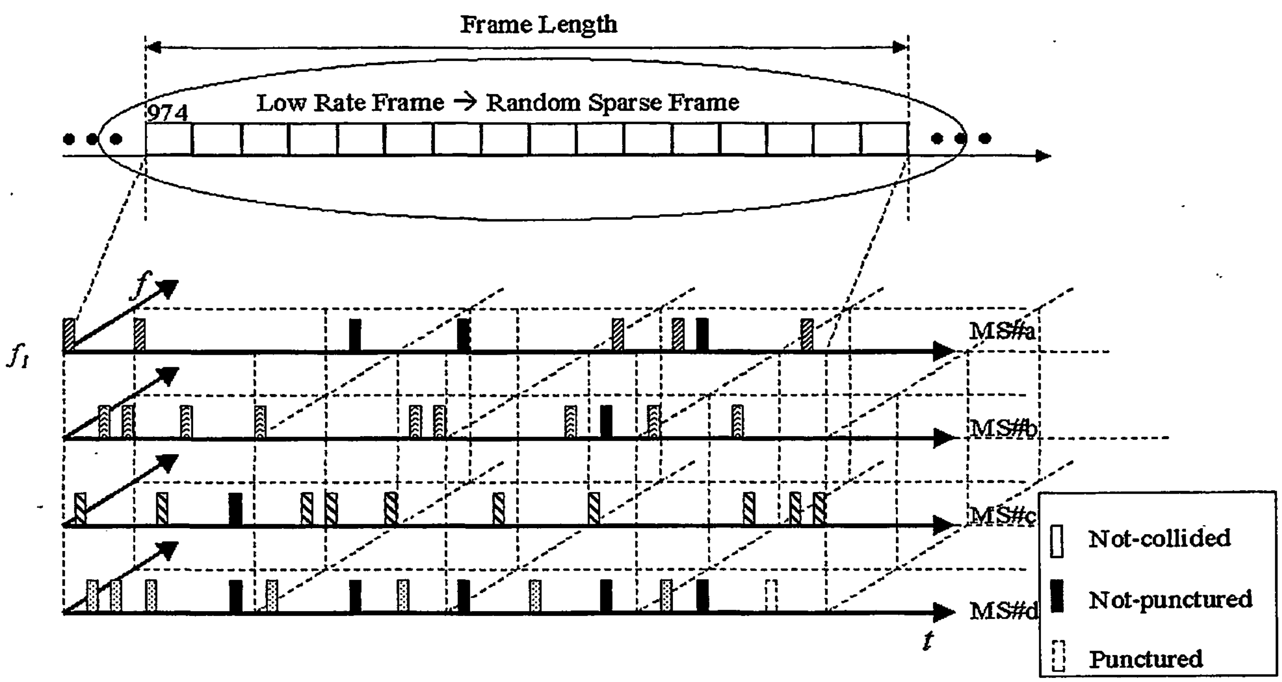


FIG. 14k

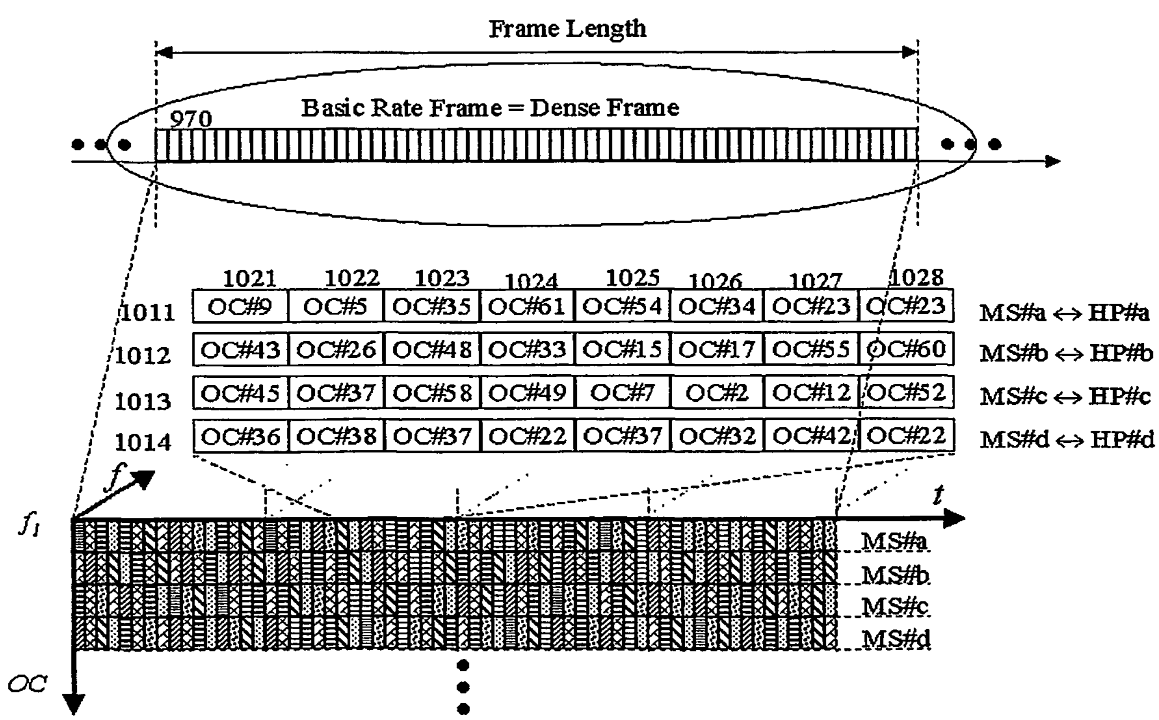


FIG. 14l

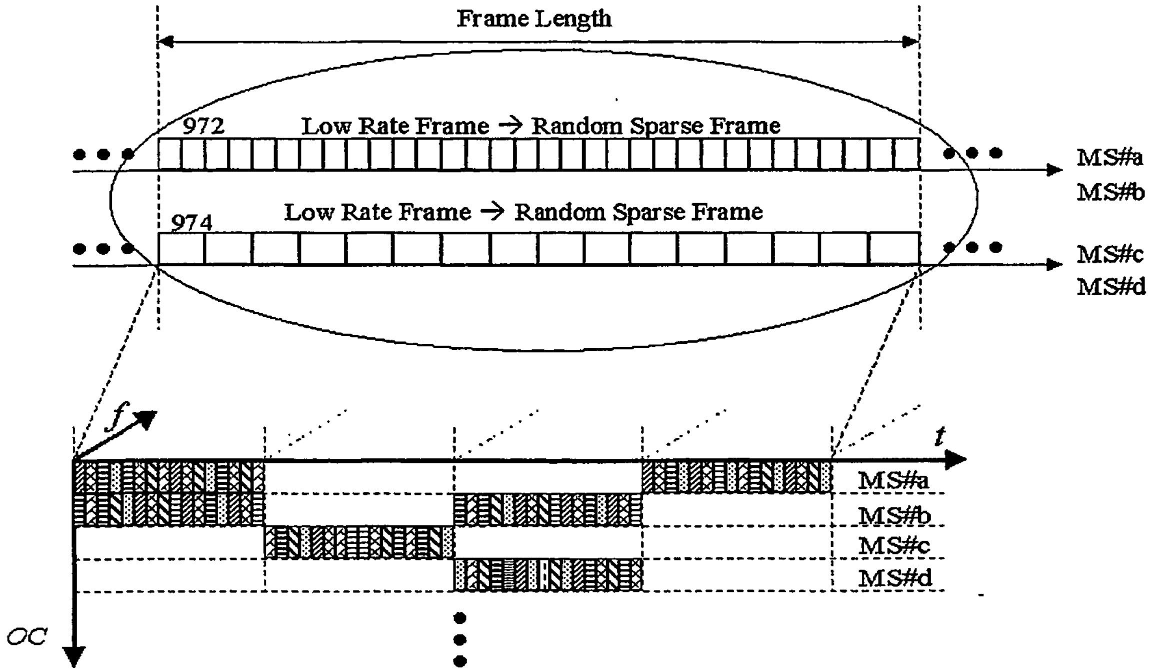


FIG. 14m

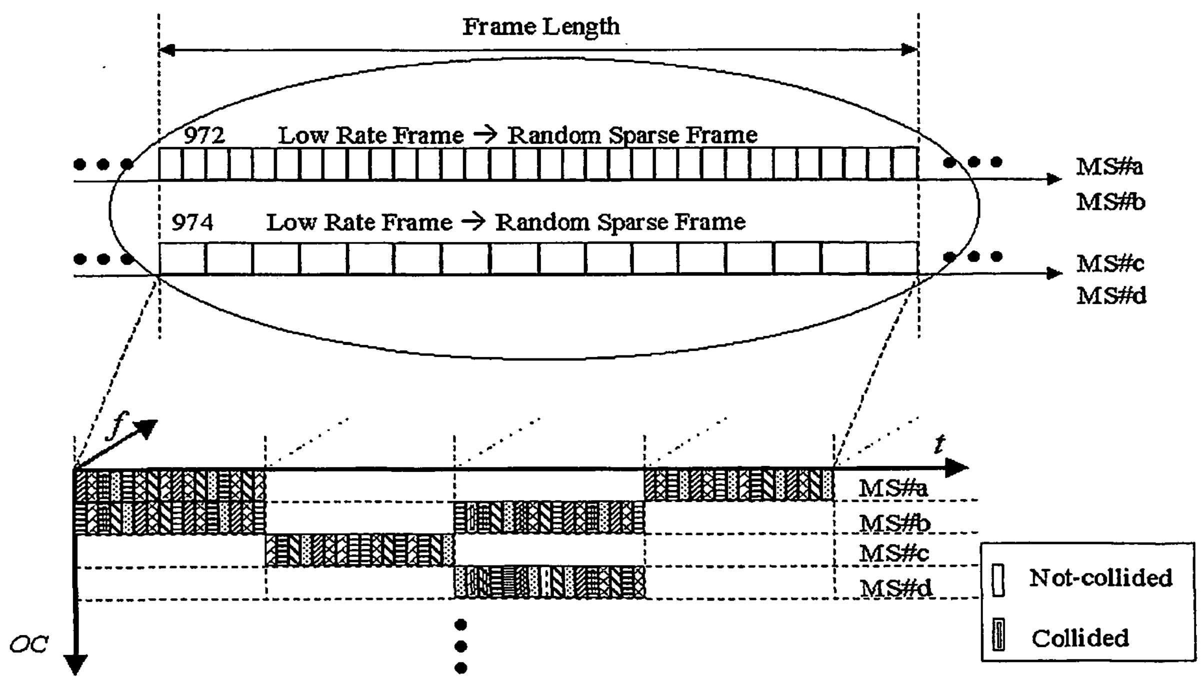


FIG. 14n

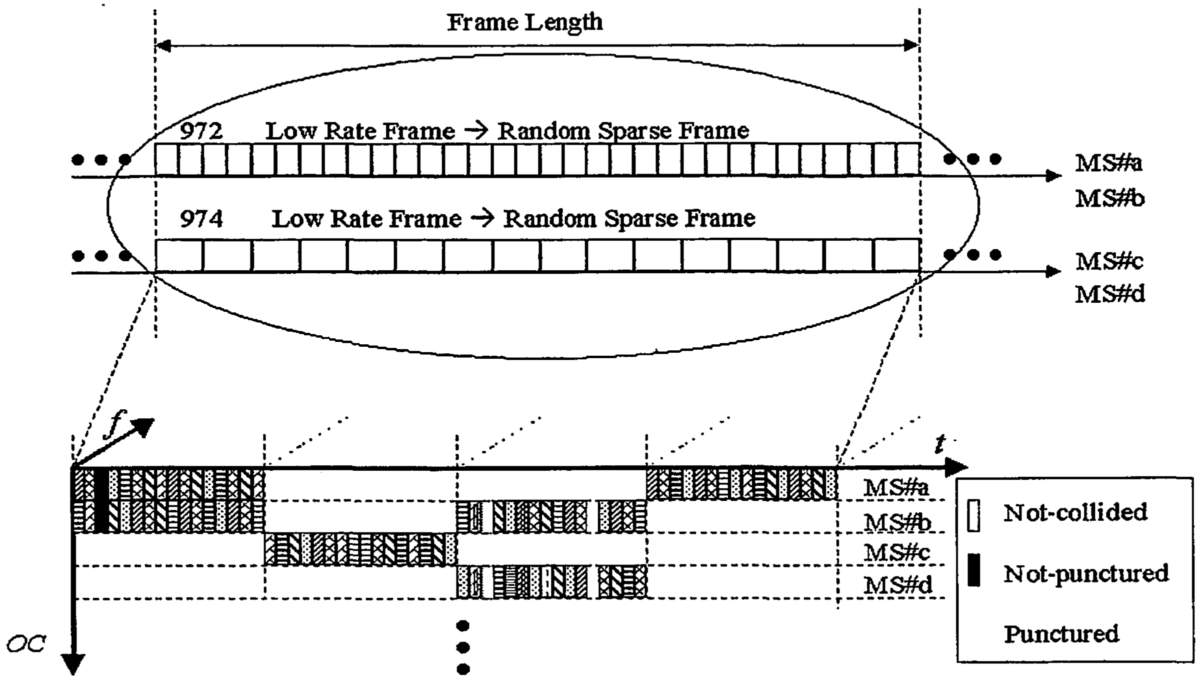


FIG. 14o

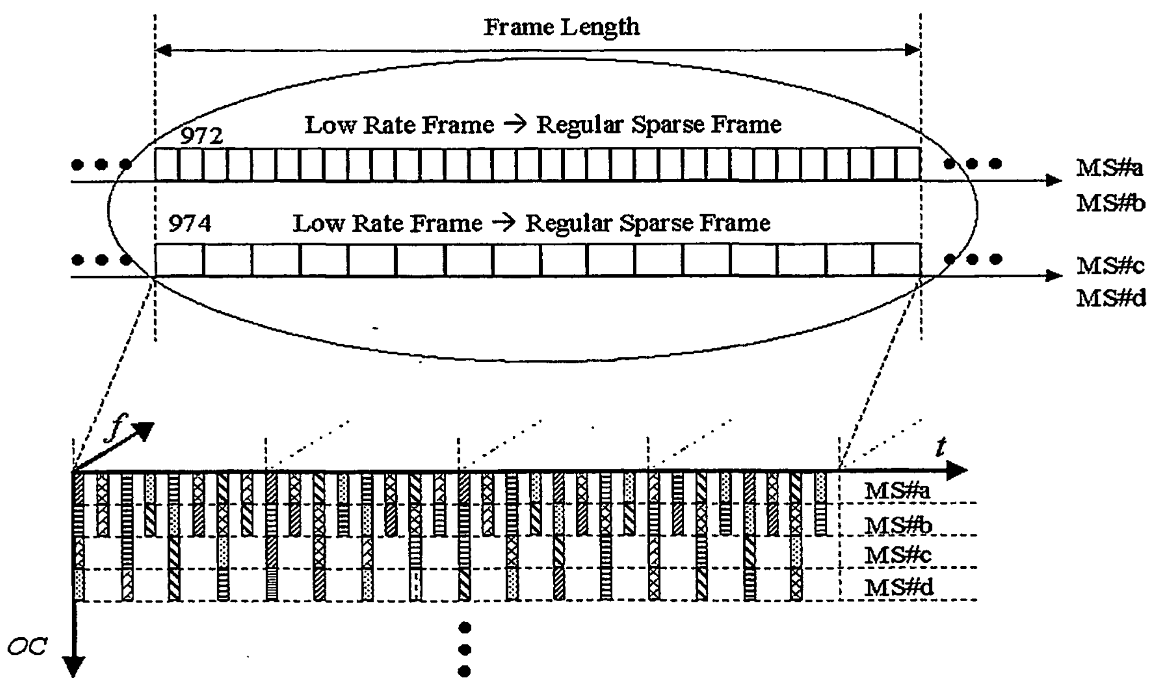


FIG. 14p

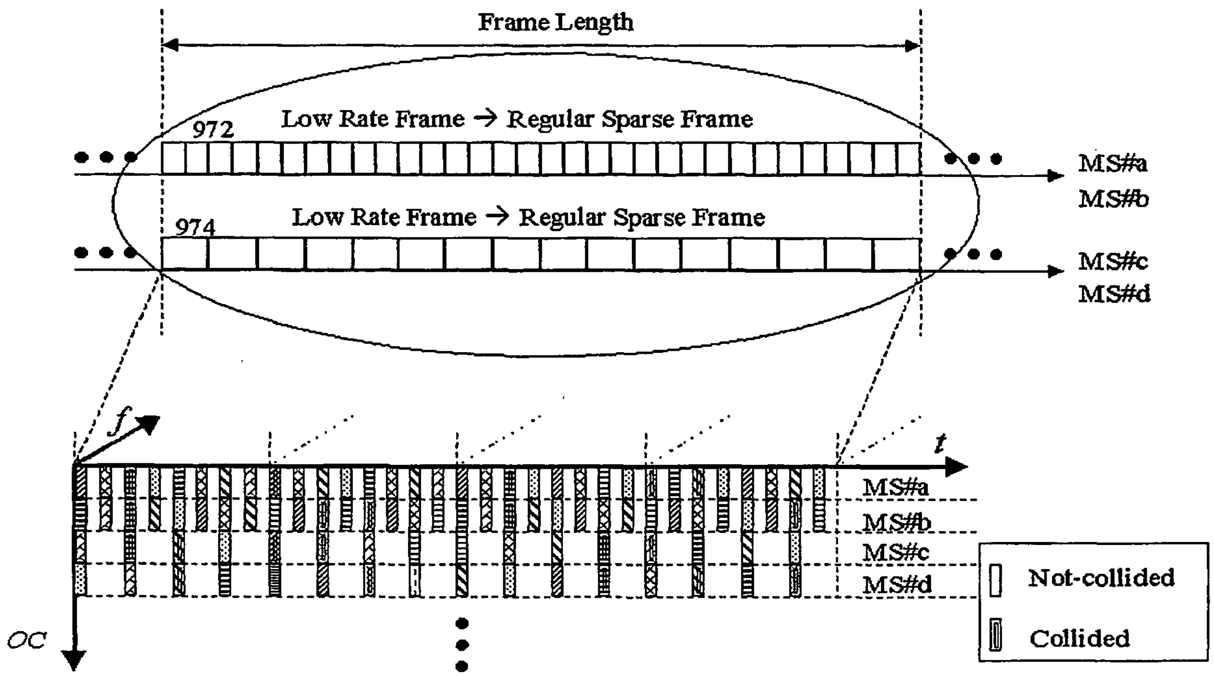


FIG. 14q

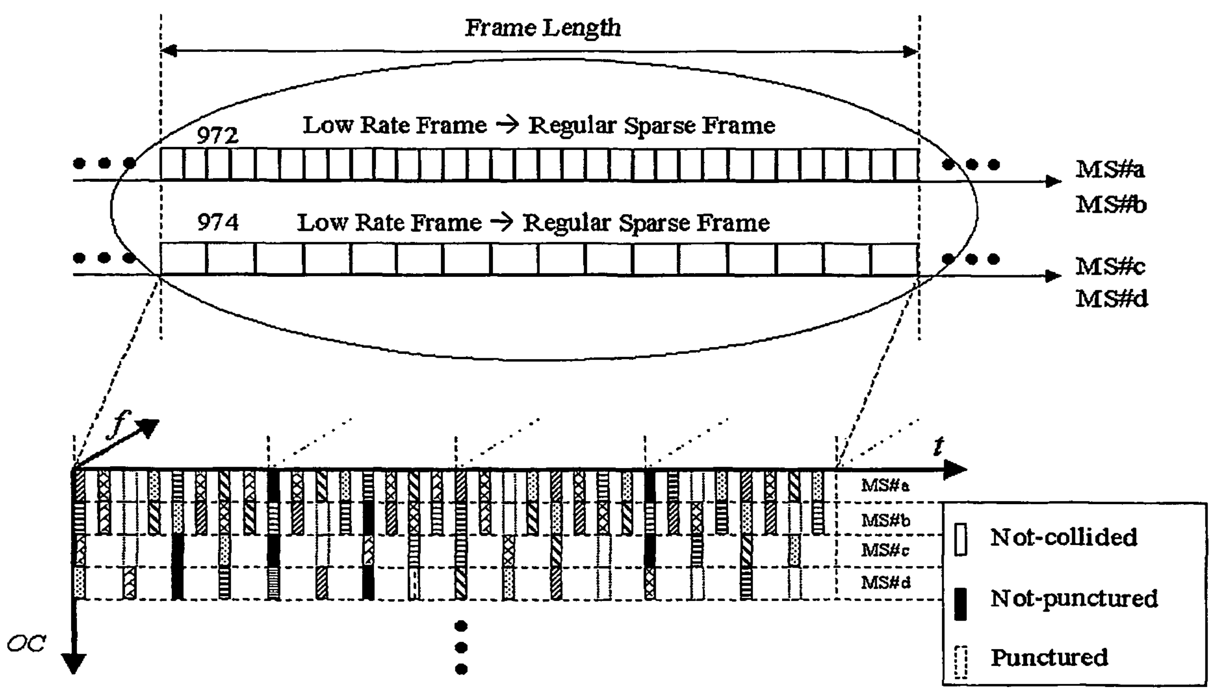


FIG. 14r

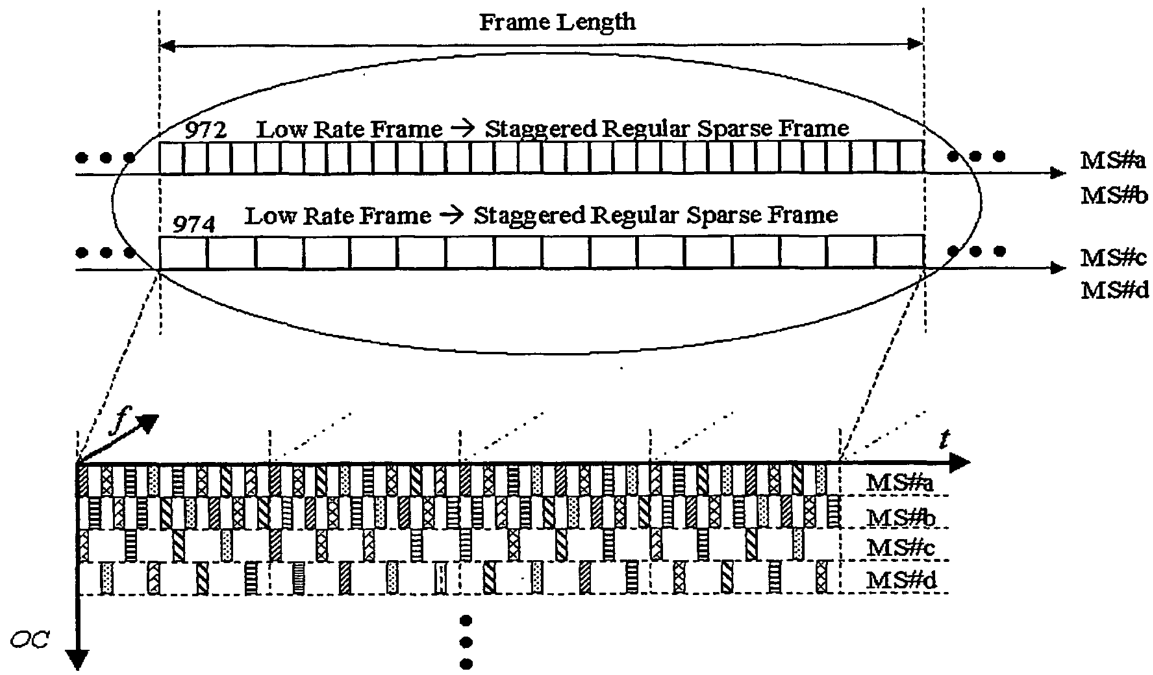


FIG. 14s

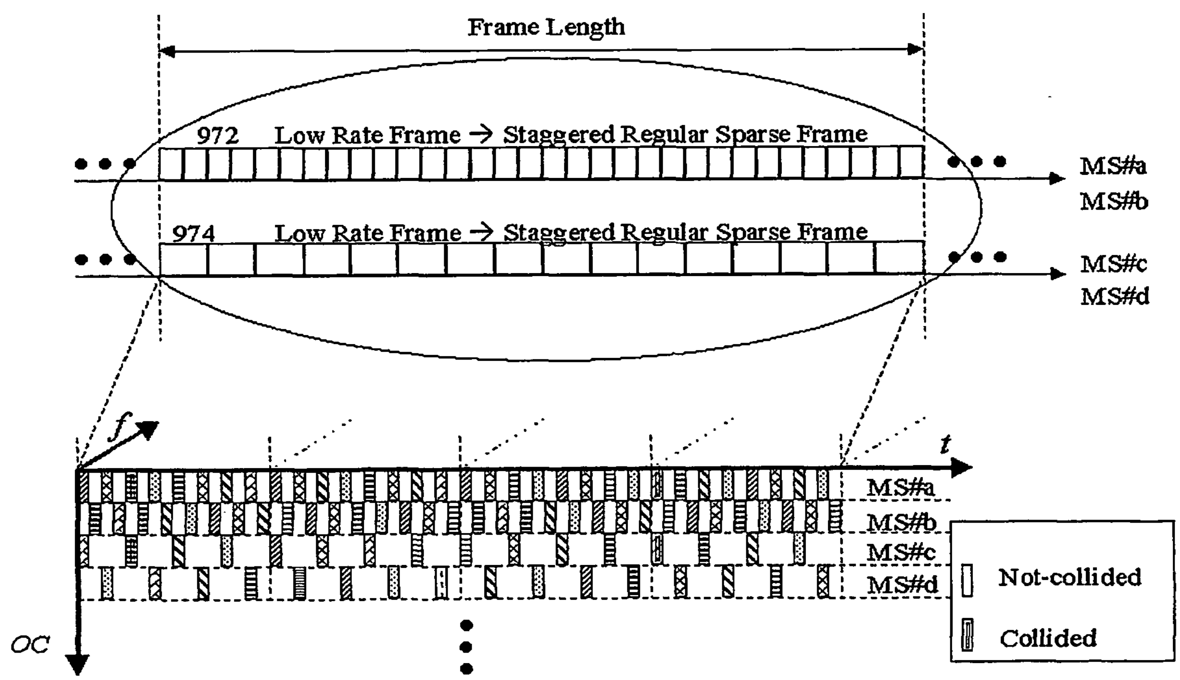


FIG. 14t

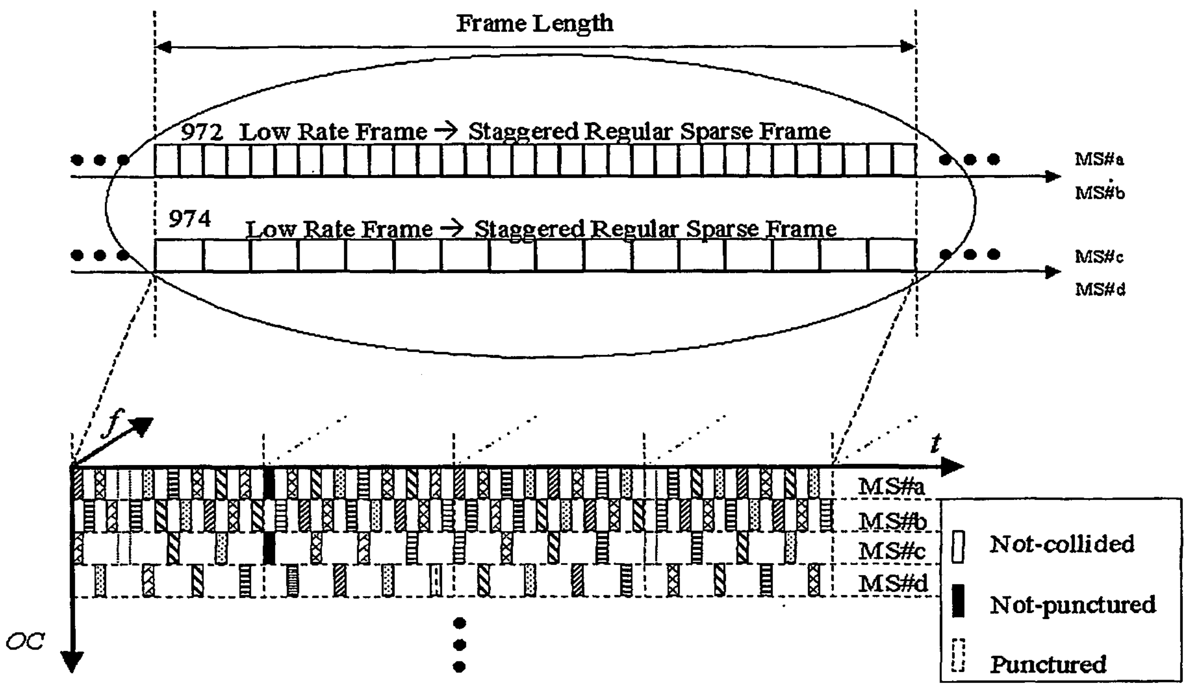


FIG. 14u

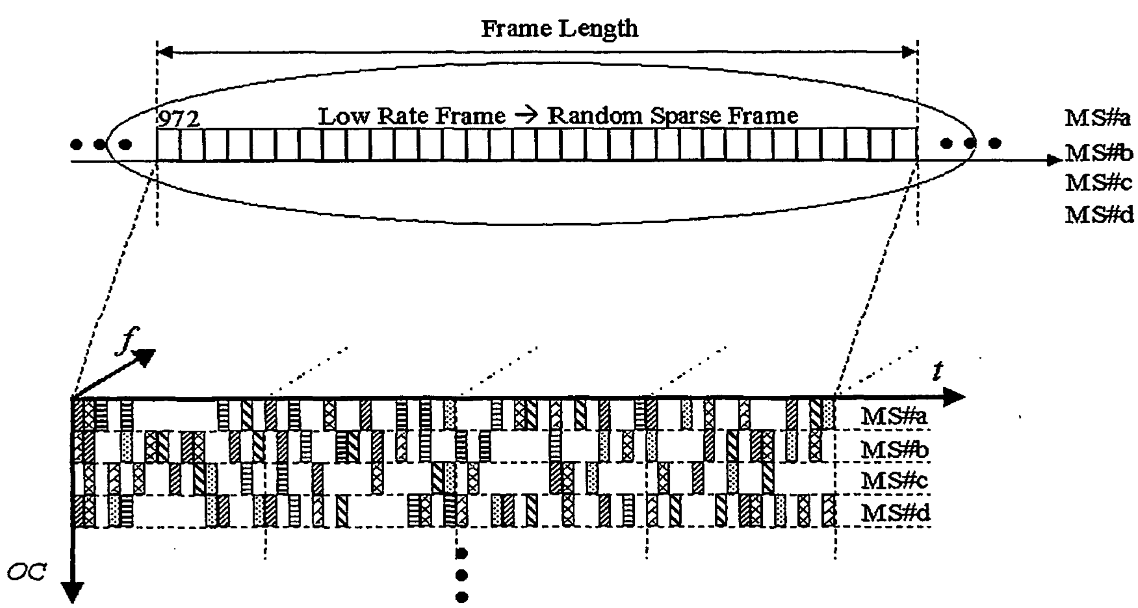


FIG. 14v

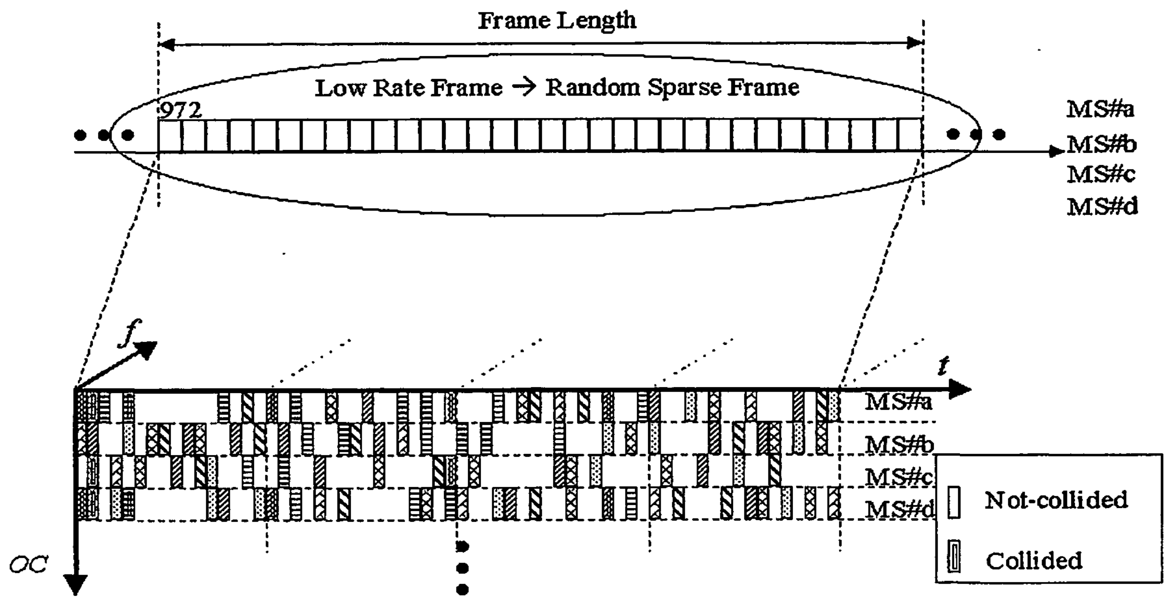


FIG. 14w

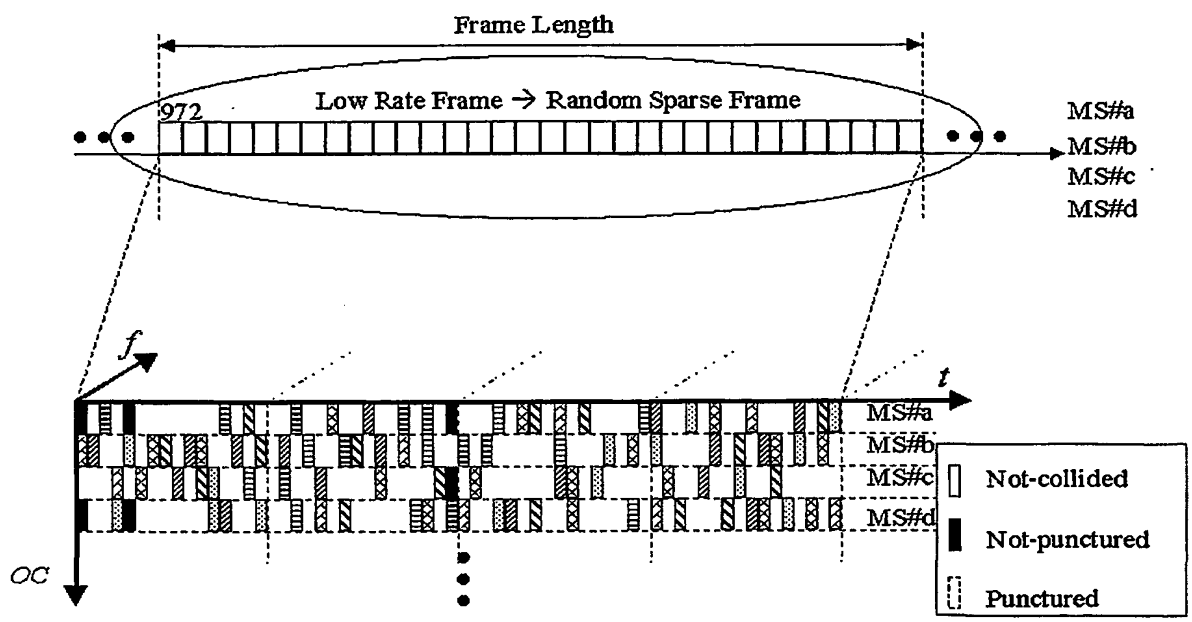
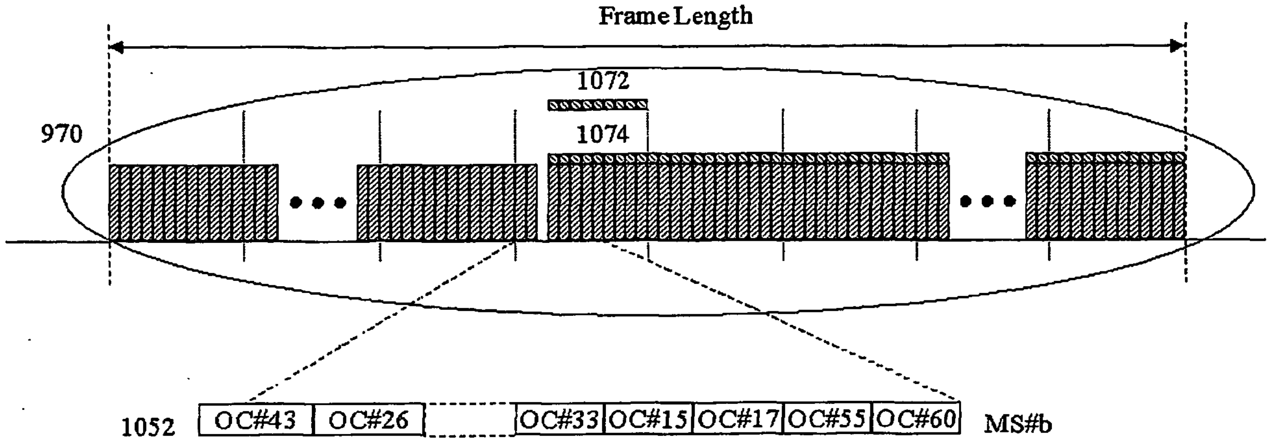


FIG. 14x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OC#33
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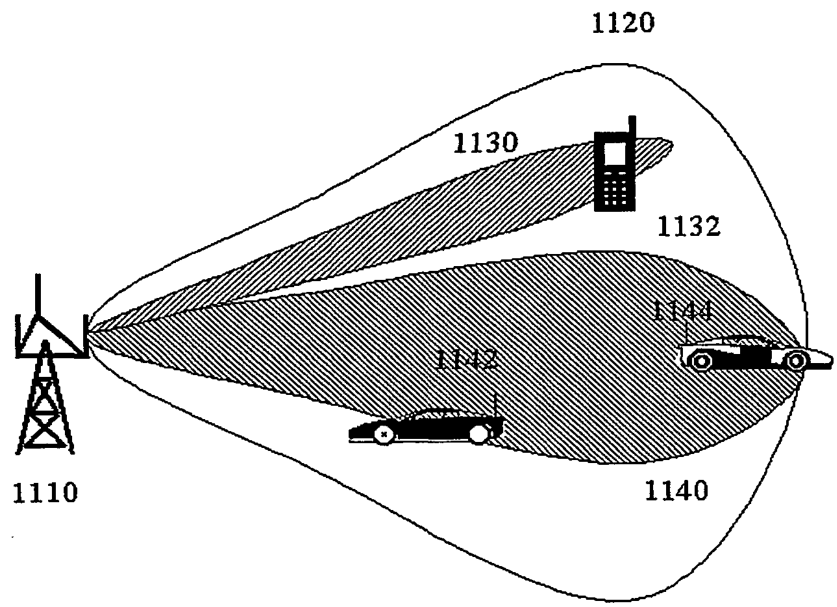
MS#b

FIG. 15


1120
1130
1132
1144
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1110
1140

FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 01/00166

CLASSIFICATION OF SUBJECT MATTER

IPC[7]: H04J 11/00, H04B 1/713

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[7]: H04B 1/69, 1/713, H04J 11/00,13/00, H04L 5/06, 27/26, 27/30, H04Q 11/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0902549 A2 (SAMSUNG ELECTRONICS CO. LTD.) 17 March 1999 (17.03.99) *figs. 4,6; claims 1-9.*	1-5,17,19,37, 39,46,47,58,59
A	US 5548582 A (BRAJAL, A. et al.) 20 August 1996 (20.08.96) *claims 1-6.*	1-5,32,33,39-42,52,57,59
A	EP 0874530 A1 (AT&T CORP.) 28 October 1998 (28.10.98) *claims 1,7,14,18.*	1,2,6,10,14,52

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
„A" document defining the general state of the art which is not considered to be of particular relevance
„E" earlier application or patent but published on or after the international filing date
„L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
„O" document referring to an oral disclosure, use, exhibition or other means
„P" document published prior to the international filing date but later than the priority date claimed
„T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
„X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
„Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
„&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2001 (13.06.2001)	3 July 2001 (03.07.2001)

Name and mailing adress of the ISA/AT	Authorized officer
Austrian Patent Office Kohlmarkt 8-10; A-1014 Vienna Facsimile No. 1/53424/535	FUSSY Telephone No. 1/53424/328

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR 01/00166

Patent document cited in search report			Publication date	Patent family member(s)			Publication date
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				JP	A2	10303941	13-11-1998
				US	BA	6229821	08-05-2001
EP	A2	902549	17-03-1999	CN	A	1278129	27-12-2000
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				JP	B2	3093182	03-10-2000
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				JP	A2	7288491	31-10-1995
				SG	A1	48266	17-04-1998